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### THE CHEMICAL INDUSTRIES OF GERMANY.

BY PROF. PERCY F. FRANKLAND, F.R.S.

It is remarkable that the Royal House of Prussia has during many centuries been associated in one way or another with chemical enterprises of various kinds. Thus already the second ruler of the country, the Markgraf John (1608—1610) was actually surnamed "the Alchemist" in consequence of the zeal with which during many years he pursued his investigations on the transmutation of metals, whilst a number of his successors exhibited great interest in the same problem—the manufacture of gold—which has never failed to fascinate the needy princes—and what princes are not needy?—of all ages and all nations. The Great Elector (1640—1688), who did so much to advance the power of Prussia, was a patron of chemistry, which was just then beginning to emerge as an experimental science from the obscurantism of alchemy. He provided the celebrated Kunkel with a laboratory and glass furnaces on an island in his park at Potsdam, and it was there that in 1678 Kunkel made the discovery of ruby glass, produced by means of traces of gold, and which is still an unsurpassed method of colouring glass for ornamental purposes. Kunkel also rediscovered phosphorus, which had previously, in 1669, been obtained by the alchemist Brand of Hamburg, who had quite accidentally produced it in the course of his attempts to extract the Philosopher's Stone out of urine. But whilst the discovery of yellow phosphorus is thus of German origin, its production on an industrial scale was, until 20 years ago, only carried on in England and France. In 1892 the manufacture of phosphorus by electro-thermic means was introduced into Germany by the Chem. Fab. Griesheim-Elektron at Frankfurt.\* Red phosphorus was discovered by Schrötter, an Austrian chemist, in 1848, and was adapted for safety-matches by the German Böttger in the same year. His invention was first taken up in Sweden, and was not adopted until 10 years later in Germany. The match industry has assumed its largest dimensions in Germany. Thus the German annual production in 1912 was £4,600,000.† The value of all matches (British and foreign) consumed in Great Britain in 1910 is estimated at £1,203,750—about 9 matches per day per head. Messrs. Bryant and May's (by far the largest English concern) turned out 1152 million boxes in 1907. This represents about  $\frac{1}{2}$  the British output. In 1907 the total value of British production was £775,000, of which £76,000 worth was exported.‡ The British export of matches is diminishing. It is worthy of note that Japan in 1901 exported matches to the value of £1,200,000.

\* The author has much pleasure in acknowledging the assistance he has received from the valuable compilation by Professor Lepsius of Berlin, "Deutschlands Chem. Industrie 1888—1913," and from that by Dr. Duisberg, of Elberfeld, "Wissenschaft und Technik," 1911.

† Molinari, "General and Industrial Inorganic Chemistry," 1912.

‡ Clayton.

**Porcelain.**—Another great German industry owes its origin to alchemistic studies made by Böttcher in the reign following that of the Great Elector, namely, that of Frederick III. (1688—1713) first King of Prussia. Having succeeded in making gold before witnesses, Böttcher was seized by order of the Elector of Saxony and was "interned" at Dresden, where, although he did not succeed in making the much-desired gold, he founded, along with the physicist Tschirnhaus, the celebrated Dresden porcelain industry.

The astute Frederick the Great (1740—1786) was anxious to manufacture the Dresden ware at Berlin and to this end commissioned his court apothecary, Johann Heinrich Pott, to institute investigations. These attempts were, however, all unsuccessful.

The Great Frederick placed much faith in secret agents and it was by means of spies that he succeeded in discovering the secrets of the Dresden porcelain manufacture, for at his instigation an enterprising merchant, bearing the name of Gotzkowski, with the assistance of a Saxon workman, brought the secrets of the Dresden process to Berlin and established a porcelain factory in the Leipzigerstrasse, which still remains the warehouse for the Berlin porcelain goods. But Frederick later stopped the pecuniary assistance with which the factory had been subsidised, and Gotzkowski was forced to sell the concern to Frederick for a sum of about £30,000, and so was established the celebrated Berlin Royal Porcelain Factory, amongst the products of which are the well-known crucibles and evaporating basins. The flourishing state of the German porcelain and pottery manufacture is attested by the fact that during the past 25 years the number of works has increased from 228 to 359, and the number of workpeople employed from 37,000 to 66,000. In 1912 the German exports of china, earthen and stoneware were valued at upwards of 3½ million sterling.

**Glass.**—Even still more important is Germany's glass manufacture, for which she has long been pre-eminent. The annual export in recent years has been over seven million pounds.

**Cyanide industry.**—In the early 18th century an accidental discovery was made by Diesbach, a Berlin colour-maker, which has proved of great industrial importance. Diesbach was preparing what is known as Florentine lake, a red pigment obtained by precipitating a solution containing cochineal extract and an iron salt with caustic potash. It so happened, however, that the potash used by Diesbach had been in contact with bone-oil, containing some cyanide, and the result was that, instead of the result he anticipated, a magnificent blue colouring matter was obtained. This substance, which is still known as Berlin or Prussian blue, was the first cyanogen compound to be discovered.

The cyanogen compounds have played a most conspicuous part in the development of organic chemistry, and every source of cyanogen has been exploited for obtaining them. In recent years the demand has increased enormously owing to the employment of sodium and potassium cyanides in the extraction of gold. To meet this demand a number of synthetical methods for their preparation have been super-added.

Germany's annual production of cyanides is estimated at 10,000 tons, of value £850,000, or about half of the world's production.

**Beet sugar industry.**—Another industry also had its beginnings in the 18th century during the reign of the Great Frederick, and was the

outcome of the laborious researches of Marggraf (born in Berlin in 1700, and a pupil of Stahl) on the occurrence of sugar in the vegetable kingdom. Of the numerous plants investigated from this point of view he found that the beetroot (*Beta vulgaris*) contained the largest proportion of saccharine material and that the sweet-tasting substance was identical with that present in the tropical sugar cane (*Saccharum officinarum*).

It was not, however, until some 50 years later that the observations of Marggraf led to the first beet-sugar factory in the hands of Franz Karl Achard, who was subsidised in this venture by the Prussian King, Frederick William III. (reign 1797—1840), who was also the founder of the University of Berlin.\*

The beet-sugar industry had to contend with strenuous competition on the part of the cane-sugar manufacturers, who were chiefly English and who are said to have endeavoured to corrupt Achard by heavy bribes. The industry was, however, greatly promoted when, in 1806, Napoleon issued his famous edict closing the European ports to British goods. The vast extent of this industry at the present time can be gathered from the following figures:—

Total sugar crop for 1912-13: Cane sugar, 9,211,755 tons; beet sugar, European (one-third German), 8,310,000 tons; beet sugar, U.S.A., 624,064 tons; total, 18,145,819 tons.

The sugar industry should give us food for serious reflection when we consider the following facts:—United Kingdom spends annually £23,000,000 on 1,700,000 tons imported sugar. Germany produces £36,000,000 worth of beet sugar on 1,300,000 acres, France produces £13,000,000 on 570,000 acres; all continental countries together produce £116,000,000 on 6,000,000 acres.† In the United Kingdom there is only one small experimental beet sugar factory in existence. The beet sugar industry is of particular interest in connection with the present European crisis, inasmuch as it is a most notable example of an industry which largely owed its successful inception to a state of war which disturbed the previously established order of things in the matter of sugar-supply.

In this country agriculture is well known to be productive of a conservative frame of mind, but that it is not so in Germany is well illustrated by the extraordinary progress which has been made in the cultivation of the sugar-beet under the guidance of systematic scientific research. Thus in 1840 100 kilos. of beet gave 5.9 kilos. sugar; in 1850, 7.3; in 1870, 8.4; in 1890, 12.5; and in 1910, 15.8 kilos. In 1871 the mean production of beet per hectare‡ was 246 quintals.§ and in 1910, 300 quintals. In 1867 the consumption of coal for 100 kilos. of beet was 35 kilos.; in 1877, 24; in 1890, 10; and in 1900, 7 kilos. Further economy in coal has been effected by means of the Kestner concentrator.||

*Sulphuric acid, soda, and bleaching powder industries.*—Sulphuric acid was discovered by the German alchemist Basil Valentine in the 15th century. The production of this fundamental acid, however, on any considerable scale took its origin in Birmingham, where Dr. Roebuck in 1746 introduced the classical leaden chamber process.

At the beginning of the 19th century it became an industry of great importance, more especially in England, because of this acid being required for the manufacture of carbonate of soda by the Le Blanc process.

The manufacture of Le Blanc soda was taken up in England in 1814, especially in connection with soap-making, and it was in England that this manufacture assumed the largest proportions. The enormous advances made in this manufacture during the past century may be gathered from the fact that the price of carbonate of soda in 1818 was about £12 per ton, whilst to-day it is only about one-tenth of that amount. One of the determining factors which made England the principal home of soda manufacture was the great development of our cotton industry during the 19th century.

During a large part of the last century England manufactured Le Blanc soda, sulphuric acid, and bleaching powder\* for most of the world. But during the latter half of the century the rival ammonia soda process made its appearance. The original discovery of the reaction on which it depends—it was first patented in England by Dyar and Hemming in 1838—is ascribed to several different persons, but the process was first made an industrial success in Belgium by M. Ernest Solvay. The Couillet Works were founded with a capital of about £6000 in 1863; the numerous affiliated works are now to be found in Belgium, England (Brunner, Mond and Co.), Germany, France, Italy, Spain, Austria-Hungary, Russia, and North America. They employ 35,000 persons. During the 50 years the price of soda has been reduced from £16 to £4 a ton. The displacement of Le Blanc soda by ammonia-soda involved the introduction of new methods of chlorine manufacture. After numerous abortive attempts in various directions, the successful production of electrolytic chlorine has been achieved, and about half of the bleaching powder in the world is now made by this means.

Electrolytic chlorine is now often converted into liquid chlorine (6d. a kilo.), of which large quantities are used at Stassfurth for the annual preparation of 500,000 kilograms of bromine, and the Badische Anilin und Soda Fabrik used in 1900 more than 1 million kilos. for the preparation of chloracetic acid employed in the manufacture of synthetic indigo.

In the manufacture of sulphuric acid, again, the old-established English or leaden chamber process has not been allowed to remain unchallenged, for since the beginning of the present century it has had to meet the competition of the so-called contact process. This is based on a long known reaction,† which, however, remained almost unutilised until the meticulous industry of German chemists and the courageous enterprise of German manufacturers developed it into a commercially successful process, which was elaborated in the works of the Badische Anilin und Soda Fabrik at Ludwigshafen.

The ammonia-soda and the contact sulphuric acid‡ processes, although carried out in this country, have been largely instrumental in making other countries, more especially Germany and the United States, independent of the English production of these all-important chemicals.

In 1882 the world's consumption of soda was 700,000 tons (180,000 am. soda), and in 1902 1,760,000 tons (250,000 Le Blanc). In England, in 1876, £7,000,000 was invested in the industry,

\* There was no University in Berlin until 1809, but the following figures will show how Prussia has made up for lost time in this respect. In 1913-14, there were 7613 male and 770 female matriculated students, and 4113 male and 89 female non-matriculated students. The annual income was £246,310, of which £204,650 came from the State, £49,900 from fees, etc., and £780 from other sources. The annual expenditure was £246,310, of which the teaching staff accounted for £104,790; departmental expenses, £106,146; building expenses, £10,510; reserve, £6650; administration, bursaries, etc., £24,000. "Minerva," 1914.

† C. W. Fielding, "Morning Post," Jan. 23, 1915.

‡ Hectare = 2.5 acre. § 1 quintal = 100 kilograms.

|| Molinari, "General and Industrial Org. Chem.," 1913.

\* Discovered by Tennant in 1799.

† This reaction had for many years been used by Messrs in England, but only for manufacture of SO<sub>2</sub>.

‡ The Clayton Aniline Co. and Nobel's Explosives Works have contact sulphuric acid plant.

which gave employment to 22,000 workpeople. In 1880 the British output was 430,000 tons, and in 1896 800,000 tons. North America in 1886 produced 1100 tons, and in 1898 300,000 tons; and Germany in 1878 made 42,000 tons, in 1901 300,000 tons, and in 1910 400,000 tons.\* The first soda works in Germany was only erected in 1843 by Hermann at Schönebeck, near Magdeburg, and the first leaden chamber by Kunheim in 1844 on the Tempelhof Plain, near Berlin.

in value. Natural rubies or sapphires of 2—4 carats cost £20—£50, and larger stones up to £150, whilst the artificial would only cost 1/500—1/1000 of those amounts.

A still more recent and much more important application of hydrogen is for the hardening of fats, which depends on the transformation of unsaturated into saturated acids by means of hydrogen in the presence of a catalyst (nickel, palladium, etc.).

*Production in tons, 1910.\**

	Germany.	England.	France.	United States.	Europe.	World.
Sulphuric acid ( $H_2SO_4$ ) .....	1,250,000	1,000,000	500,000	1,200,000	3,700,000	5,000,000
(of this by contact process) .....	400,000			250,000		
Soda .....	400,000	700,000	200,000	250,000		2,000,000
(of this Le Blanc Soda) .....	30,000	120,000				150,000
Saltpetre consumption .....	786,000	93,000	337,000	523,000	1,740,000	2,360,000
(of this for nitric acid) .....	150,000			50,000		
Hydrochloric acid (30%) .....	450,000	†				
bleaching powder .....	100,000					300,000
(of this electrolytic) .....	70,000					150,000

\* Duisburg, "Wissenschaft und Technik," 1911.

† Already in 1895 the estimated production of hydrochloric acid in England was 1 million tons, and for the whole of Europe 2 million tons. (Molinari.)

*Hydrogen industry.*—The electrolytic production of soda and chlorine is of course attended with the evolution of enormous volumes of hydrogen. At first this gas was allowed to go to waste, but gradually interesting and important uses have been found for it; (1) Dirigible balloons, rendered possible by taking advantage of the lightness of the internal combustion engine. One horse-power engine is but little heavier than 1 kilogram. 27,000 cub. metres of hydrogen is required for a modern airship. The balloon sheds are often established near electrolytic soda works, or the gas may be transported in steel cylinders compressed to 150 atmospheres. 500 cylinders containing 2750 cub. metres of gas are placed on one railway wagon, and more than 8 such wagon-loads are required for the filling of a single Zeppelin. (2) Autogenous welding with oxyhydrogen flame. These most important applications of hydrogen were introduced at the beginning of this century by the Chemische Fabrik Griesheim-Elektron. The oxy-acetylene flame is now more commonly used. (3) Artificial gems by means of oxy-hydrogen flame. Some 30 years ago C. V. Boys succeeded in fusing quartz with the oxyhydrogen flame and then drawing it out into incredibly thin fibres, which have proved of the highest value for certain physical experiments of extraordinary delicacy. The same source of heat was much later, in the nineties, employed by the French investigator, Michaud, to reconstruct rubies from small fragments of this gem. At the beginning of this century Verneuil and Paquier, in Paris, succeeded in making synthetic rubies. A little later Wild, Miethe, and Lehmann in Germany elaborated methods for producing synthetic corundum, rubies, amethysts, and sapphires, which are manufactured by the Elektrochemische Werke at Bitterfeld. These products are identical in chemical composition and physical properties with the natural gems, and the rarest varieties of these can be obtained at will. Fused alumina (very pure) gives corundum; fused alumina + 24% chromic oxide gives ruby; fused alumina + magnesia and titanium oxide and ferric oxide gives blue sapphire. These synthetic gems are now manufactured to the extent of about 6 million carats annually (1 carat = 0.205 gram), or 1230 kilograms or more than one ton. Experienced connoisseurs can, however, distinguish between the natural and artificial gems, with the result that the former have not diminished

*Industries connected with artificial illumination.*—The world is greatly indebted to Germany for inventions which have largely revolutionised artificial illumination, firstly, in connection with gas and more recently in respect of electric lighting.

Thus, one of the most remarkable discoveries in this domain was that of incandescence gas lighting, which was made by the Austrian Count Dr. Carl Auer v. Welsbach of Rasternfeld in Styria, as the result of lengthy, laborious, and ingenious researches. The now so familiar gas-mantles are prepared by the ignition on the cotton frame of a mixture of thorium nitrate, 99; cerium nitrate, 1%.

The source of these rare earths is monazite-sand, the elaboration of which has become a very important industry depending on fractional crystallisation, which already many years ago was brought to such a high pitch of perfection in the laboratory of Sir Wm. Crookes. Out of this monazite-sand, Otto Hahn, in 1910, succeeded in extracting mesothorium, and the process is carried out on a large scale at the works of Dr. O. Knöfler and Co., at Plötzensee near Berlin. Radium bromide is worth about £17 a milligram, mesothorium about £7 10s. a milligram. The mesothorium is only present in the monazite sand in extremely small proportion, about 1 part in 150 million parts of the mineral.

I may also refer to Auer-metal, a preparation of iron (Fe 30%) containing cerium, which sparks when scratched with hard steel, and which is familiar as a substitute for matches.

*Electric light metallic filaments.*—Another outlet for the use of hydrogen has been in reducing the rare-metals osmium (m. pt. 2500° C.), tantalum (m. pt. 2300° C.), and tungsten (m. pt. 2850° C.).

In 1903 the Auer Company showed that the carbon filament of incandescence electric lamps could be replaced by an osmium filament with an economy of 50—60% of current. In 1905, Siemens und Halske showed that a tantalum filament was cheaper and more advantageous, and in 1906 that the tungsten filament was even still better. Tungsten occurs in sufficient quantity in nature as wolframite (iron tungstate) and scheelite (calcium tungstate) to enable the metal to be now sold as filament-metal for 6s.—7s. a kilogram.

Some idea of the enormous and increasing scale on which the incandescence lighting manufacture

\* Molinari.

is carried on in Germany may be gathered from the following figures :—

	1911.	1912.
Metallic filament electric lamps .....	47,211,892 pieces	76,185,721 pieces
Carbon filament electric lamps .....	24,791,196 „	20,975,348 „
Incandescence gas mantles .....	126,050,954 „	135,320,173 „
Arc-lamp carbons .....	10,740,025 kilos.	11,093,154 kilos.

According to V. B. Lewes, the consumption of gas-mantles in 1912 was :—Germany, 100,000,000 ; America, 60,000,000 ; England, 38,000,000 ; France, 16,000,000 ; Belgium, 3,500,000 ; Italy, 3,000,000 ; Russia, 1,500,000.

The special tax imposed in Germany on lighting apparatus realised from the above sources in 1912 was £800,000. This remarkable tax was one of those extraordinary financial expedients resorted to by Germany during recent years to provide the wherewithal for the stupendous national effort to subjugate Europe of which we are the witnesses to-day.

**Ammonia.**—Of the commoner inorganic chemicals which are produced on the largest scale, one of the most important is ammonia, which has for so many years been obtained as a by-product in the manufacture of coal gas.

So backward was this industry in Germany, that actually even as late as 1874 the ammoniacal liquor from their gas works was run to waste. All the more remarkable is the state of affairs to-day as betrayed by the following figures. The world production of ammonium sulphate was 210,000 tons in 1890, 500,000 tons in 1900, and 1,330,000 tons in 1912. Germany's production of ammonium sulphate in 1912 was about 370,000 tons.

The principal use of sulphate of ammonia is as a nitrogenous manure, as which it competes with Chili saltpetre: they may be taken as of equal money value per unit of nitrogen. In this connection Germany's manure bill is interesting :—

	1888.	1912.
	tons.	tons.
Chili saltpetre* .....	225,000	650,000
Sulphate of ammonia .....	50,000	500,000
Superphosphate .....	250,000	1,800,000
Basic slag .....	250,000	2,200,000
Crude potash salts .....	160,000	3,000,000
Lime .....	500,000	800,000
Other manures .....	500,000	500,000
Total value .....		£30,000,000

\*The total import of Chili saltpetre into Germany in 1912 was 800,000 tons, of which only 150,000 tons was used for manufacture of potassium nitrate and nitric acid.

It is the ambition of the Germans, firstly, to make themselves independent of the industrial products of other countries, and secondly, to produce in excess of their own needs and to impose this surplus on the rest of the world. Thus, they pride themselves on displacing more and more of the foreign Chili saltpetre by home-made sulphate of ammonia, and in 1911 they used in agriculture 75,000 tons of ammoniacal nitrogen against 70,400 tons of foreign saltpetre-nitrogen. This partial success they look forward to making complete and decisive by developing new methods of producing ammoniacal nitrogen and nitrates which can be carried out in Germany. Of such methods there are already two in operation, and they are associated with that great problem which

confronts mankind as a whole. How to supply the combined nitrogen which will be necessary to build up the food-stuffs for the teeming millions of the future, after the deposits of Chili saltpetre are exhausted? This is the same problem as that of fixing the nitrogen of the air, which long ago, before anything was known of nitrogen at all, man had solved empirically by growing leguminous plants in the rotation of his crops, thereby increasing the fertility of the soil, although the mechanism of this time-honoured procedure was only experimentally demonstrated in the last decades of the 19th century by the German investigators, Willfahrt, Hellriegel, and Nobbe.

**Fixation of atmospheric nitrogen by inorganic means.**—This has been successfully accomplished by :—

(1) The Birkeland and Eyde electric furnace, and the Schönherr electric furnace of the Badische Anilin und Soda Fabrik. These are simply realisations on the industrial scale of laboratory experiments made by Cavendish 130 years previously. This method is applicable only in Norway or other countries where abundance of water power renders the production of cheap electrical energy possible. It is being carried on by an international company at Notodden in Norway. They propose to use 300,000 horsepower capable of yielding 150,000 tons lime-saltpetre (15—20% N) or about 1/3 of the total amount of Chili saltpetre used by the world. Germany possesses but little water-power so that this process is of only indirect interest in connection with German chemical industry.

(2) Fixation of nitrogen by calcium carbide at high temperatures. This discovery was made by the German chemists Frank and Caro. £5,000,000 capital is already embarked in this industry by various companies of Europe and America. About 120,000 tons is produced annually, about one-quarter of which in Germany. The crude calcium cyanamide (about 20% N) may be used directly as a nitrogenous manure or may be made to yield ammonia. The production of calcium carbide involves the use of the electric furnace and hence cannot be carried on economically on a very large scale in Germany owing to the limited water-power available.

(3) Combination of nitrogen and hydrogen at higher temperature and especially under high pressure. The long known fact that the reaction,  $N_2 + 3H_2 = 2NH_3$ , is realised to a very small extent at high temperatures has been investigated in recent years by Haber and Le Rossignol at Karlsruhe, and, guided by the principles of modern physical chemistry, Haber has elaborated, after overcoming extraordinary technical difficulties, an industrial process which promises to be of great importance in the future. The most advantageous conditions were found to be :—Pressure 200 atmospheres; temperature, 500° C.; catalytic agent, osmium, uranium, etc.

Production of ammonia by the Haber process has been carried out on a commercial scale by the Badische Anilin Co. since the summer of 1913, and a plant capable of yielding 130,000 tons of sulphate of ammonia per annum was to have been ready during the present year. Inasmuch as the German Colour Syndicates have severed their connection with the Norwegian nitre undertaking, it would appear that they regard the Haber ammonia process as being more likely to be capable of capturing the inorganic nitrogen market of the world.

This synthetic production of ammonia obviously involves cheap hydrogen. I have already referred to electrolytic hydrogen, but there are cheaper sources. Thus water-gas contains theoretically equal volumes of hydrogen and carbon monoxide; the carbon monoxide (b. pt. —192° C.) can be

removed by liquefaction from the hydrogen (b. pt.  $-253^{\circ}\text{C}.$ ). Similarly the nitrogen required for the process is obtainable from the fractional distillation of liquid air. The synthesis of ammonia thus dovetails with the possibilities of cheap low temperature production for which the world is so largely indebted to the German engineer Carl von Linde of Munich.

The German ambition to make their combined nitrogen at home does not stop at the production of synthetic ammonia, for there are still large requirements in respect of nitrates (Germany produces upwards of £1,500,000 of nitric acid annually from Chili saltpetre) which have to be satisfied from foreign sources. They hope, however, to fill this gap in the home-production of combined nitrogen by utilising a reaction discovered by Kuhlmann\* as long ago as 1839, in which ammonia and air burn to nitric acid in the presence of platinum as a catalytic agent.

**Potash salts.**—Germany appears to be alone in possessing vast deposits of potash salts, whilst the enormous value of these to agriculture was first demonstrated by Liebig and made public by him in his "Application of Chemistry to Agriculture and Physiology" in 1840. This work may without question be regarded as the foundation stone on which agricultural chemistry has been raised. The celebrated deposits of potash salts were accidentally discovered in 1857, when boring for rock-salt at Stassfurth, near Magdeburg, in Prussia. Their industrial exploitation on an ever increasing scale was begun in 1861 by Grüneberg and Adolf Frank. In 1861 the production of crude potash salts was 2000 tons; in 1912, 11,000,000 tons, worth £8,800,000. 90% is used as manure (about one-third in Germany itself), and 10% in industries (about two-thirds being worked up in Germany for carbonate, caustic, nitrate, alum, chromate, and chlorate, etc.). America is now experimenting with a view to obtaining potassium chloride from feldspar by the method used in the laboratory for determining alkalis in insoluble silicates, and which consists in heating the silicate with a mixture of lime and calcium chloride. Whether it has any commercial future remains to be seen.

This is a matter of prime importance in the United States as potash salts are there used on an enormous scale, especially for agriculture, thus they consumed in 1900 Stassfurth potash salts worth £840,000; in 1910, £2,440,000; and in 1911, £3,040,000.†

**Explosives.**—I have already mentioned the importance of nitrates and of nitric acid, and have referred to the employment of the greater part in agriculture; of the remainder the major part goes in the manufacture of explosives and in the coal tar colour industry.

Black powder or gunpowder is said to have been discovered by the English monk Roger Bacon (1214-1294). Gun-cotton was discovered by Schönbein in Basle and Christian Böttger in Frankfurt in 1846.

Nitroglycerin was discovered by Sobrero in Pelouze's laboratory in Paris in 1847, and first manufactured on a large scale as an explosive by the Swede Alfred Nobel in 1862.

The disruptive properties of gun-cotton are greatly moderated by gelatinising by means of solvents (acetone, acetic ester, alcohol and ether, etc.), and by mixing with nitroglycerin ballistic materials like cordite, and other smokeless powders are obtained. There is another class of explosives which combine great safety in handling with enormous disruptive effect. Picric acid (discovered by Woulfe of London in 1771), but first used by the French under the name of

Melinite for filling shells in 1881, and later by the English under the name of Lyddite. More recently this has been replaced by trinitrotoluene, first proposed by Haeussermann in 1891 for filling shells and used by our Service under the mark "T.N.T." It is even less sensitive to shock than picric acid. "Ammonal," used by the Austrians for shell-filling, is a mixture of T.N.T. with ammonium nitrate, charcoal, and aluminium powder. It is both very safe and very powerful. T.N.T. is much used for demolishing bridges. It is so insensitive to shock that it is not exploded on being struck by a rifle-bullet, and when in a shell it withstands the impact of the latter piercing an armour plate.\*

Tetra-nitro-aniline, obtained by Flürscheim, enjoys the unique position among explosives of having been discovered in this country. It is said to be equally safe and even more powerful than trinitrotoluene.

According to the late Oscar Guttman the production of nitroglycerin explosives in 1909 was as follows:—United States, 20,000; Germany, 10,300; England, 8,100; Transvaal, 8,000; Canada, 5,000; Spain and Portugal, 3,500; Austria-Hungary, 2,300; France, 1,500 tons; Switzerland, Australia, Norway and Sweden, 600 tons each; Russia, Italy, Holland, Belgium, 500 tons each; Greece, 175 tons.

Explosives are of enormous importance also in civil life—in mining and engineering modern explosives have greatly accelerated progress and have rendered possible such works as the Panama Canal. They are also being now employed with great advantage in afforestation for loosening the ground in which trees are to be planted. The manufacture of explosives in Germany is very highly developed. The total German production of 40,000,000 kilos. includes dynamite explosives, 10,000,000; ammonium nitrate explosives, 16,000,000; and black powder, etc., 14,000,000 kilos. There were exported in 1908 value about £1,000,000; and in 1912, £3,000,000.

The world-production of explosives is now about 400,000,000 kilos. or 10 times the German total output. We have at Ardeer, in Scotland, the largest explosives factory (Nobel's) in the world, covering 850 acres, employing 1800 men and 700 women, and producing annually about 16,000 tons of all kinds of high explosives.

**Artificial silk.**—An eminently peaceful industry which is closely related to that of explosives is the production of artificial silk and celluloid. The manufacture of artificial silk has grown up during the past 25 years, for this product was first shown by Count Hilaire de Chardonnet at the Paris Exhibition of 1889; he discovered the method of its preparation whilst a student in the Ecole Polytechnique at Paris, and in 1891 formed a company at Besançon with a capital of £240,000 for its manufacture.

The chief kinds of artificial silk are:—(1) Nitrated cellulose (soluble in alcohol-ether) silk (denitrated by ammon. sulphide) (Chardonnet silk). (2) Ammonocupric oxide cellulose silk (Pauly, Fremery, or Urban silk, of the Vereinigte Glanzstofffabrik, Elberfeld, 1897). (3) Viscose-silk (CS, in presence of NaOH or Ca(OH)<sub>2</sub>, on cellulose), (Cross and Bevan). (4) Acetate-silk (acetic acid on cellulose), (Cross and Bevan).

Germany produces about 2,000,000 kilos., value about £1,200,000, exports 600,000 kilos., and imports 1,800,000 kilos.; the imported is principally "alcohol silk," due to disadvantageous alcohol tax in Germany. Germany is the principal user of artificial silk, although the fundamental discoveries upon which the manufacture is based are largely due to French and English chemists.

\* Ann. Chem. und Pharm., 1839, 29, 280.  
† Mellmer.

\* Macnab, "Explosives" Inst. of Chem. Lecture, 1914.

The world production is estimated at about 7,000,000 kilos.

The distribution of the industry may be gathered from the following:—France, 7 factories; Germany, 8; Belgium, 3; England, 2; Spain, 1; Austria-Hungary, 4; Russia, 3; America, 3; Japan, 1.

Great profits have been made out of artificial silk (some of the companies have paid 50–100% dividends), and the price has greatly fallen since its introduction from 28s. to 32s. per kilo in 1903, 16s. in 1906, and 12s. (poorer qualities, 6s. to 8s.) in 1910.

The cellulose industries furnish a particularly striking example of the manner in which chemical research and invention are able to enhance the value of the kindly gifts of the earth. Thus, 1 cub. metre of wood has value as fuel about 6s.; (after boiling with lime, soda, and sulphite) as paper pulp, £1 12s.; ditto as paper, £2 16s.; pulp converted into artificial silk, £80 to £240.

*Industries dependent on synthetic organic chemistry.*—It is out of the profound study of synthetic organic chemistry which has been made during the past 60 years that the industries of artificial dyes, drugs, and perfumes have incidentally arisen. The earlier and pioneering achievements in synthetic organic chemistry are well distributed amongst the nations of Europe,\* but during the major part of the 60 years the great bulk of the discoveries in this domain have been made in Germany. Organic chemistry is, perhaps, the branch of science which more perfectly suits the German mind and temperament. It involves the possession of those qualities in which Germans are so pre-eminent—the capacity for taking an infinitude of pains, the capacity to anticipate difficulties and organise means to circumvent them. It is, moreover, only possible to make substantial advances in the problems of organic synthesis if the master has at his disposition a number of highly qualified and docile assistants and apprentices; in a word, the master must be at the head of a large and efficient school of research. It is in the possession of such schools of research, both in the universities and in the chemical factories, that Germany has by two generations the lead of all other countries in the world. Whilst most of the professors of chemistry in our own universities and colleges have under great difficulties and without any sort of encouragement been more or less successful in building up such schools of research, which are, however, by no means slavish imitations of the German model, the chemical manufacturers of this country have, with some notable exceptions, failed to establish anything worthy of the name of research laboratories in connection with their works.

It is in respect of the works research laboratory that there is the greatest contrast between the chemical industries of Germany and those of other countries, and it is not surprising, therefore, that the present war should have served to emphasise the class of chemical products for which we are almost entirely dependent on Germany.† It is precisely those products—artificial dyestuffs, artificial drugs, and artificial perfumes, which are the outcome of the works research laboratories, that are now in many cases unobtainable in consequence of the cutting off of the German sources.

The seriousness of the situation is apparent from the following figures, relating to dyestuffs alone:—The value of dyestuffs consumed in England annually is £2,000,000, and the value of trade in which these dyestuffs are employed is £200,000,000, whilst upwards of 1½ million workmen are depen-

dent upon these industries. The total value of dyestuffs imported into the United Kingdom in 1913 was £1,892,055, of which Germany contributed £1,730,821.

Perhaps the most concise way of conveying a superficial idea of these industrial products of organic synthesis will be by means of the following classification:

*I. Artificial products.*—Colours first obtained from aniline by Runge in 1834, by the action of bleaching powder. Aniline colours: Mauve was discovered by Perkin in 1856, and Magenta by Verguin in 1859. Azo-colours\* were discovered by Griess in 1859, and introduced on an extended scale in 1878. The azo-colours have achieved an enormous importance and have practically banished cochineal and logwood from the dyeworks. Some 2000 azo-colours in use. Congo-colours, substantive cotton dyes, were discovered by C. Böttger in 1884.

It must not be supposed that British colour manufacturers have been idle from the days of Perkin; thus in 1880 a very original departure was made by Messrs. Read, Holliday and Sons, who introduced the principle of developing azo-dyestuffs on the fibre with their so-called Ingrain or ice colours. Some of these have achieved a great success, thus 2000 tons of *p*-nitraniline are now annually manufactured for the production of nitraniline-red and similar colours.† Again, the discovery of Primulin and the colours which can be derived from it by A. G. Green in 1887, is another very notable achievement.

Eosin colours were discovered by Caro in 1873.

*II. Artificially produced natural products.*—This group contains substances occurring in nature and long valued by man. The chemical nature of these substances has been carefully ascertained by chemists who have then deliberately set to work to devise methods for their artificial preparation at such a cost as to compete with and ultimately supplant the natural product. These campaigns against the commerce in the products of nature undoubtedly constitute one of the most remarkable phenomena in the history of the world.‡ Bear in mind, it is the production and supply to man of the actual products of nature, but more cheaply than they can be produced and supplied by Nature herself. These endeavours have already been successful on a very large scale.

*Alizarin* (the essential principle of the madder root) was first synthesised by Graebe and Liebermann in 1869. At the time of this discovery, the world production of madder was 50,000,000 kilos, roots (1–1½% alizarin), representing ½–¾ million kilos, alizarin, value, £2,250,000. In 1870 France had 20,000 hectares (50,000 acres) under madder cultivation, which soon disappeared after the introduction of the artificial product.

The production of artificial alizarin was: 1873, 100,000; 1877, 750,000; 1884, 1,350,000; 1900, 2,000,000 kilos. (four-fifths of this was produced in Germany).

A great number of most valuable artificial dyestuffs, more or less closely related to alizarin, but not occurring in nature, have been prepared by chemists, and the total value of the alizarin-colour exports of Germany at the present time is about £1,000,000.

*Indigo.*—This most highly prized blue dyestuff of both the ancient and the modern world was first artificially synthesised by Adolf Baeyer in 1880, but it required 17 further years of unremit-

\* Both azo and eosin colours were kept as secret products, but the colours were investigated by Hofmann and their mode of production published, to the great consternation of the inventor.

† G. T. Morgan, "Modern Dyes and Dyestuffs," Roy. Dublin Society, 1914. Cain and J. F. Thorpe, "The Synthetic Dyestuffs and Intermediate Products," 1913.

‡ England and France were, however, more especially to the fore.  
† Only about 1/10 of the annual value of dyestuffs consumed in England is produced in our own country.

ting and laborious investigation in the works of the Badische Anilin und Sodafabrik at Ludwigshafen, and the investment of nearly £1,000,000 before laboratory synthesis was translated into a commercially successful industry, for it was in 1897 that the artificial indigo was put on the market.\*

In 1896 the world production of plantation indigo (100%) was 6,000,000 kilos., value £4,000,000: four-fifths of this was British, obtained from 1,500,000 acres in British India. In 1904 only 500,000 acres was under cultivation, and in 1913, only 300,000 acres.

	British East Indies.		Germany.	
	Exports.		Imports.	Exports.
	Cwt.	Value, £	£	£
1896 .....	188,337	3,569,670	1,036,000	319,550
1898 .....	135,127	1,980,310	415,450	332,250
1902 .....	89,750	1,234,837	184,350	923,100
1905 .....	49,252	556,405	60,100	1,286,050
1908 .....	32,490	424,840	44,100	1,932,750
1909 .....	16,939	225,000	22,300	2,091,500
1913-14 .....		60,000—70,000		

The price of indigo (100%) in 1897 was 16s. per kilo, and in 1913 7s. per kilo.

By varying the ingredients in the indigo-synthesis, many very valuable dyes related to indigo have been obtained. Thus the chlorine and bromine substituted indigos are manufactured as Ciba-blue, Brilliant-indigo, and Bromo-indigo. Again with sulphur instead of oxygen, Thio-indigo-red, and Thio-indigo-scarlet. Moreover, by using the anthracene-grouping in the indigo-synthesis a number of most important colours have been obtained, e.g., Indanthrenes, of extraordinary fastness to light; Alizarin-indigo; Algal-colours (Rob. E. Schmidt), in all varieties of colour, and of the greatest fastness to light. The discovery of these valuable dyestuffs provoked zealous emulation on the part of the azo-colour chemists, who responded by placing some very excellent new products on the market under the name of Benzolight colours.

*Antique or Tyrian Purple* was perhaps the most highly prized of all colours in the ancient world. We know from Pliny that this dye was obtained from a rather rare snail living in the Mediterranean, and which he describes under the name of "purpurea." Paul Friedländer, of Darmstadt, succeeded in 1909 in extracting this colour from certain glands of two different species of snail—*Murex brandaris* and *Murex trunculus*—which appeared to correspond to Pliny's description of "purpurea." He removed these glands from 12,000 individual snails, developed the colour by a short exposure to sunlight, extracted it with suitable solvents and recrystallised it from quinoline. In this manner he obtained only 1½ gram. of the colouring matter, so that its extreme costliness, which Friedländer estimates at about £2000 a kilo., is not surprising.

On investigating the chemical nature of this colour he found that it was identical with the already known synthetical compound 6,6'-dibrom-indigo.

*Drugs and perfumes.*—Not less remarkable are the achievements of organic synthesis in connection with pharmaceutical and perfumery products.

The production of artificial drugs and perfumes is in general only a branch of the artificial colour industry, for in many cases the raw materials

are the same, whilst the methods of investigation and synthesis are of course identical. But whereas the artificial colour industry started in England, that of artificial drugs is entirely of German origin, and may be said to begin with the discovery by Liebig of chloroform in 1831, and of chloral hydrate in 1832. It was in 1869 that the chemical works of Schering, on the suggestion of O. Liebreich, produced chloral hydrate as a commercial article.

In 1887 began the discovery of artificial antipyretic drugs, the rivals of the natural quinine. The first of these was antifebrin, the properties of which were discovered accidentally in consequence of a mistake. A specimen of acetanilide in a Strassburg pharmacy was erroneously supposed to be naphthalene, and was served out as such for some pharmacological experiments by Kahn and Hepp. On being taken, internally, its antifebrile effect was observed. Fortunately there was enough left for analysis, and it was found that the supposed naphthalene was the long known acetanilide, which soon acquired a great vogue for this purpose. About the same time antipyrin was discovered by Knorr, who erroneously thought that it was chemically related to quinine, and that it would, therefore, not improbably possess antifebrile properties. Direct experiment showed that it did actually possess these properties in a high degree, but subsequent research showed that it was in no way chemically related to quinine. These and numerous other artificial antipyretics have been a great source of income to their inventors in consequence of the continued prevalence of influenza during the past quarter of a century.

During the period that antipyrin was protected by patent it was sold at £6 per kilo., whilst on the expiration of the patent the price was reduced to £1 per kilo., which still allows a good margin of profit.

These discoveries have led to the systematic study by direct experiment on animals and human beings of innumerable chemical compounds with a view of ascertaining their physiological properties. The enormous amount of most laborious work which has been carried out in connection with synthetic drugs may be gathered from the fact that up to 1912 about 5000 artificial products had been found to possess therapeutical value of one kind or another, but of course comparatively few of these have permanently established themselves in medical practice. Time does not permit me to do more than refer briefly to some of the simpler and better known synthetic drugs.

Thus of antipyretics, which have or have had some considerable vogue, are: antipyrin; tolypyrin (dimethyltolylpyrazolone); salipyrin (antipyrin-salicylate); antipyrin mandelate (tussol, for whooping cough); neopyrin; pyramidon (three times as strong as antipyrin) (dimethylamino-antipyrin); antifebrin; phenacetin (cheapest antipyretic excepting antifebrin, about 6s. per kilo., and less poisonous than antifebrin); lactophenin, lactyl-p-phenetidine; aminophenacetin or phenocoll (also has an antiseptic action).

The above series derived from aniline affords a good illustration of the dependence of physiological properties on chemical constitution. Aniline itself is a powerful antipyretic but is extremely poisonous owing to its ready absorption and action on hæmoglobin. By introducing the acetyl group the toxic properties are much reduced owing to its greater stability, although acetanilide is slowly hydrolysed with liberation of aniline, so that after a time the symptoms of aniline poisoning may supervene. The observation that acetanilide is partially oxidised in the system to *p*-aminophenol led to derivatives of the latter being tried. Thus phenacetin has been found to possess

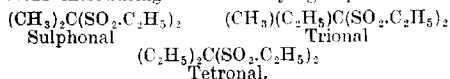
\* Bayer's first patent for the synthesis of indigo from *o*-nitrobenzoic acid was taken out in 1880, and by 1907 there had been no less than 816 patents obtained in Germany for processes connected with the preparation of indigo.



powerful antipyretic and greatly reduced toxic effects.\*

**Hypnotics.**—Sulphonal was accidentally discovered to possess hypnotic properties in connection with experiments on the transformations of sulphur compounds in the animal system. A dog, which had been dosed with the newly discovered sulphonal, in Baumann's laboratory at Freiburg, i. B., was found to fall into a deep sleep.

More powerful hypnotics were found to result from introducing further ethyl groups:—



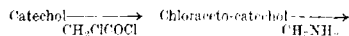
In connection with the manufacture of sulphonal, I may refer to an interesting difficulty which was experienced by the Elberfeld Colour Works (Bayer and Co.) owing to the appalling smell of the mercaptan from which it is prepared, and of which Emil Fischer and Penzoldt have shown that the human nose is still capable of appreciating 1/400,000,000 mgrm. In spite of this, German thoroughness has been successful in so perfecting the apparatus in which the manufacture is carried on that no nuisance is occasioned.

**Veronal** (diethylbarbituric acid) (E. Fischer and Mering, patented by Merck in 1903) is one of the most widely used hypnotics. Although it was formerly supposed to be practically free from toxic properties, in recent years cases of veronal poisoning have been known to occur.

**Antineuralgics.**—Salicylic acid, one of the first drugs to be artificially prepared (Kolbe 1860), acetyl-salicylic acid (aspirin), and salol (phenyl-salicylate), though extremely simple synthetic products, are almost exclusively made in Germany, with the result that their price has now greatly increased. Even synthetic phenol, which is necessary for the above preparations, was exclusively made in Germany and kept down the price of coal-tar phenol. The price of phenol has now enormously increased from 3½d. per lb. to 1s. 4d. per lb., and is likely to go higher. (Pharm. Journal, 1915.)

**Anti-gout drugs** (Uric acid solvents).—Piperazine (discovered by Hofmann in 1890), lysidine, urotropine (hexamethylene tetramine), atophane (α-phenyl-cinchonic acid).

**Suprarenine.**—This is of special interest. The active principle of the suprarenal glands known as adrenalin† had for some years been found to be of great value for increasing the blood-pressure, contracting the blood-vessels, and arresting hæmorrhage. It requires the suprarenal glands of 40,000 oxen to prepare 1 kilo. of adrenalin, but this substance has been artificially synthesised by F. Stolz, and is put on the market as suprarenine by the Höchst Colour Works. The synthesis of adrenalin may be represented thus:—



Natural adrenalin is lævo-rotatory; the synthetic can be resolved by tartrate; the lævo is 15 times as potent as the dextro.

The German colour manufacturers are organised into two principal groups or trusts (Interessengemeinschaft). (1) Badische Co., of Ludwigshafen; Bayer Co., of Elberfeld; Berlin Aniline Co. (2) Cassella Co., of Frankfurt; Meister, Lucius, und Brüning, of Höchst.‡

The share-capital of the above two groups in 1911 was £8,000,000, paying a dividend of 25·8%, and probably now about £12,000,000, dividend, 28%.

\* "Chemistry of Synthetic Drugs," P. May, 1911.

† Discovered by Takamine in 1901.

‡ "German Coal Tar Companies," Textile Mercury, Jan. 9, 1915.

In 1860–70, Germany imported about £2,500,000 worth of dyes per annum, while in 1912, Germany exported about £10,000,000 and produced about £12,500,000 of dyes.

The composition of the personnel who carry on these German colour works is at the bottom of their success. Take the Works of Messrs. Meister, Lucius, und Brüning as an example. In 1913 the composition was as follows:—Workmen, 7680; managers, 374; expert chemists, 307; technologists, 74; commercial staff, 611. Contrast with the above the fact that the six English factories now producing dyestuffs employ altogether only 35 chemists, whilst evidence of their relative activities is again furnished by the circumstance that between 1886 and 1900 the English firms took out only 86 patents, whereas the six principal German firms were responsible for 948 during the same period.

Having shown that these German coal-tar colour manufacturers are without rivals from the commercial point of view, I feel it to be my duty to point out also that their industry is carried on under conditions of labour which are highly creditable to the management.

This vast and highly organised industry of dyestuffs and fine chemicals, which is certainly one of the most outstanding manifestations of the modern German spirit, was formerly very dependent on England for its chief raw material, coal-tar, and it is interesting to see how effectually Germany has emancipated herself from a control which might at any time become irksome or even paralysing.

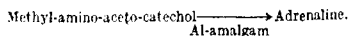
#### German coal-tar production.

	Coke ovens.	Gas manufacture.
	tons.	tons.
1897 .....	52,000	
1900 .....	93,000	
1904 .....	277,000	225,000
1908 .....	632,400	300,000

In 1908, 40,000 tons was still imported from England, and in 1909, 18,000 tons, but 35,000 was also exported.

In 1900 the German production of coal tar was only about one-half of that produced in England, whilst by 1912 it had equalled if not surpassed the English production. Again, in 1880, Germany used 1400 tons of pure anthracene, of which only 200 tons was of German origin, whilst at the present time the 5000 tons now employed in Germany is all produced there.

The phenomenal increase in the German coal tar production has depended on a similarly rapid development of the German iron and steel industry, which has entailed an enormous demand for



metallurgical coke in the production of which the greatest attention has been devoted by Germany to the recovery of the by-products—tar, gas, ammonia, etc.

In England the quantity of coal-tar treated was 175,000 tons in 1870, and 640,000 tons in 1880; at present over 750,000 tons is treated.

With regard to the synthetic perfume industry, the facts are in many respects essentially similar to those in connection with the artificial dyestuffs. The production of artificial perfumes, in many cases the identical substances which are produced by nature, has assumed very large proportions in Germany, the annual output being estimated at about £2,500,000. It is again particularly noteworthy that one of the first steps in the realisation

of this remarkable achievement of artificially building up the natural perfumes was also made by William Henry Perkin, who in 1858 succeeded in synthesising coumarin, the highly valued odorous principle of the woodruff (*Asperula odorata*).

The effect of artificial synthesis on the price of natural perfumes may be gathered from the following examples:—

	Price of 1 kilo.	
	Natural.	Synthetic.
Coumarin .....	£25	£1 5 0
Vanillin .....	£50	£1 10 0
Heliotropin .....	£150	10 0

The facts which I have brought forward speak for themselves and proclaim in the most convincing manner the stupendous progress which has been made by Germany in the chemical industries during the past 40 years. It is equally certain that England, once pre-eminent for chemical manufactures, has not progressed at the same rate and is at the present moment suffering much inconvenience through being so largely dependent on German chemical products of one kind and another. The country is now reaping the harvest of humiliation which it has sown for itself in spite of the warnings repeated *ad nauseam* by the chemical profession during a whole generation. The systematic neglect of chemical science and the failure by manufacturers to utilise the services of highly qualified chemists, could only lead to the result that all the industries which are dependent on a profound knowledge of chemistry should tend to disappear from our midst and pass into the hands of those who are prepared, not only to apply new chemical discoveries to industry, but even to prosecute the most varied chemical investigations in the hope of sooner or later making discoveries which shall be of advantage to their commercial undertakings. The mischief caused through the neglect of chemistry by practical men in this country has been so subtle that to a large extent it has remained concealed from the average man of intelligence and from the governmental classes. During the past 40 years our country has been accumulating wealth in an altogether unprecedented fashion, so that the loss or restriction of some industries appeared a matter of unimportance to political observers taking only a broad and superficial survey of the national resources. The whole of our arrangements have evolved during the past half century on the assumption that this country would never again be engaged in a European war, whilst still more recently the new democracy has vainly boasted that it could prevent such a war by means of a general strike. The year 1914 has seen the dissolution of many fool's paradises and has given the *coup de grace* to all these vain imaginings, with the result that we find our vast textile industry in serious peril because the much smaller dyestuff industry has been complacently allowed to slide into the hands of our sagacious and more painstaking enemies. The same carelessness and want of foresight had even allowed us to become dependent on Germany for some of the most important materials used as explosives, e.g. trinitrotoluene, and for many of the most valued drugs required alike by our Army, Navy, and civil population.

The complete breakdown in our supply of fine chemicals, which is the direct outcome of the disregard of the constant warnings emitted by scores of British chemists, has led the Government of the day to intervene and attempt to remedy

the intolerable state of affairs which has arisen in connection with the supply of coal-tar colours.

We devoutly hope that success will attend the endeavour to establish the coal-tar colour industry in these Islands on the largest possible scale. Whatever the ultimate scheme adopted may be, I would venture to point out that it must be based on a clear understanding of the following considerations:—

1. That the provision of the required chemicals during the continuance of the war is one thing, and that their production on a commercial basis after the cessation of hostilities is quite another matter.
2. It appears to me that in order to provide the needful supply during the war, the only reasonable course is to assist in every possible way those firms which are already making similar or closely allied products so as to enable them to produce their present goods on a larger scale, and as far as practicable to undertake the manufacture of others which are urgently required. The immediate problem will be also greatly facilitated by utilising supplies obtainable from neutral powers, and more especially from Switzerland, which is the only country, other than Germany, in which the manufacture of dyestuffs and similar chemical products has been vigorously prosecuted. As a matter of fact, Mr. Runciman admitted in the House a short time ago that the Government had granted licences to trade with the enemy in the matter of dyestuffs!
3. As regards the prospects of the home industry after the war, it will require "nursing." I use the term advisedly in order to obviate the employment of another and much more familiar one which is so dear to some politicians and so hated by others; it will require nursing for a much longer period of time than has hitherto been mentioned. In this connection I would point out that the sum of £10,000 a year for 10 years, which it has been proposed to guarantee for research purposes, is absurdly inadequate.
4. If the industry is to prosper it will not only have to manufacture materials already known, but also continually to be introducing new products of its own discovery, as well as constantly to be seeking to produce more economically a great number of auxiliary chemicals required in the manufacturing processes. It is also essential that the undertaking should branch out into the manufacture of other materials as occasion may arise for advantageously utilising by-products.
5. The competition which the industry will have to suffer from Germany is likely to be much more serious than is generally supposed, because it must be remembered that England only takes, as we have seen, about one-fifth of the total German exports of dyestuffs, so that it would be comparatively easy for German firms specially to reduce the price of the goods sent to England. They have already done this in America when attempts have been made to start an aniline industry there. It is particularly significant, and augurs ill for the prospects of this scheme to rehabilitate the coal-tar colour industry, that the latter has failed to flourish anywhere excepting on German soil, and that countries with fiscal systems entirely different from our own have been no more successful in this respect than have we ourselves.
6. It will certainly be necessary that expert chemical knowledge should in the future be much more highly remunerated than it has been in the past, otherwise the supply of able and properly qualified men will not be forthcoming. The flow of men of high grade intelligence into a profession is determined by the prizes which the profession has to offer, in the form of money and social position. Consider the great stream of able men who are attracted to the English Bar, in which profession the prizes, although limited in number, are of the most substantial kind, with the result that the successful leaders are selected by the fiercest competition in a very wide field.

If there is to be a large influx of high intelligence into the chemical profession, it will be necessary that there should be some very different prizes from the paltry bait which is offered at the present time, for the study of chemistry in this country now only draws those men who either have or think they have an overpowering zeal and passion for the science, to which they devote themselves against the advice of their friends, and in spite of the warnings of the professors of chemistry by whom they are initiated. Notwithstanding the absence of material inducements, I venture to say without fear of contradiction that there is more original investigation being prosecuted in this country by chemists than by any other body of British men of science, and this I attribute to the fact that such a large proportion of our number have either been at German Universities or are the pupils of those who have been at these centres of research. Nor are any of us, I am sure, even during this unfortunate crisis, unmindful of the hospitality and the inspiration which we have received in the schools of the enemy. 7. If the proposed undertaking is to succeed, real chemists must be on the directorate, and in a sufficient proportion to give effect to their views. Many men of science are excellent business men. What does experience teach in the case of flourishing chemical industries which we fortunately still have amongst us? What does not the firm of Messrs. Brunner, Mond and Co., for example, owe to the late Dr. Ludwig Mond, F.R.S.? 8. In attempting to establish a commercially successful coal tar colour company on a large scale in this country, I venture to think that the Government have undertaken a task which they will find to be surrounded with difficulties of quite a different order from those which they have had to encounter in some of their most striking previous legislative acts, such as the provision of salaries for members of Parliament, the granting of Old Age Pensions, and the establishment of a compulsory system of Insurance. These are matters in which if the Government dictate we are obliged to obey, but the commercial success of an industry which is based upon progressive scientific investigation depends upon factors so subtle and elusive that they cannot be coerced even by a majority of the House of Commons. 9. If the chemical industries are to be rehabilitated in this country, there must be a complete change in the attitude of mind towards science in general, and towards chemical science in particular, amongst the influential classes of the population, and it will certainly not be effected by following the precept "business as usual," but by pursuing a policy which is the exact opposite of what is implied by that vulgar and undignified phrase.

### London Section.

*Meeting held at Burlington House on Monday, February 1st, 1915.*

MR. W. F. REID IN THE CHAIR.

Mr. J. J. EASTICK moved the following resolution:—

"That in the opinion of this Meeting representing the London Section of the Society of Chemical Industry, the Council of the Society should petition the Government to take such steps as will tend to the permanent production and refining within the Empire of sugar sufficient for the Empire's consumption."

He said that he was firmly convinced that with a trade to be captured equal to £18,000,000 sterling there was ample room for both beet and cane, and for all their Colonies.

Unfortunately in the past no united efforts of an Imperial nature had been made to formulate a comprehensive scheme that would serve the interests of the whole Empire. That was now necessary if supplies of sugar at a normal price to the consumer were to be secured. The present cost was equivalent to an enormous tax on the consumer and the manufacturer. Sugar was the only food in which the British working-classes were being penalised more than their enemies. They had become dependent upon Germany and Austria for a million and a quarter tons of sugar every year. That was the bulk of their supplies. The Board of Trade returns showed that 80% of their sugar was beet-grown sugar from the Continent, and only 20% represented cane, a very small proportion of which 20% was from the colonies.

In competing with the enemy's trade or industry, in many cases they were handicapped by patents, but in the sugar industry they lacked nothing. Their engineers, both English and Scotch, made the most substantial sugar machinery in the world. Their agriculturists had made successful experiments in cultivating sugar-beets. Their cane-fields only required permanent conditions to expand rapidly. Every civilised nation with a suitable climate, except Turkey and Persia, had succeeded in providing for the bulk of their sugar supplies within their own borders, and why should not the British Empire do likewise? They had to look forward at once for supplies. Even if they were in peaceful communication with the Continent in a few months, it would be a long time before the beet industry could get in full working order. The factories in Belgium, France, and Russian Poland were practically demolished. There were a few isolated cases where they were working, but it would be a long time before normal days came again.

He thoroughly and firmly believed in the desirability and feasibility of producing their own beet sugar in England at a profit. No excise duty had yet been levied on sugar, although the Anglo-Netherlands Company had been in operation three years.

Captain COURTHOPE, M.P., in seconding the Resolution, said that he cordially agreed there was plenty of room in the British Empire for both beet and cane. The United Kingdom consumption of beet sugar alone represented a value of roughly some £20,000,000, or upwards, per annum, and it was the product of over a million acres of land each year. The Cantley factory was built about three years ago by an English company entitled the Anglo-Netherlands Sugar Corporation, and was financed very largely from the Continent. They had had three years of uphill work, in contending with unforeseen difficulties, but he hoped they were on the way to the establishment of the industry and ultimate prosperity.

They had had also to overcome the reluctance of the farmer to start a new crop. It was particularly important from the farmer's point of view that the beet industry should be established. If the beet industry were established here, it would unquestionably have the effect of largely increasing their production of white straw crops, and the arable acreage. The arable farmer had to work out his profit and loss account, not on a single crop of a single year, but over four years of his rotation, or whatever the period was. There was hardly a case where wheat, by itself, if it was ever brought to harvest at all, did not show a profit; but there were thousands of cases in which the profit on the wheat, oats, or barley was so small that it was swamped or more than swamped

by the loss on the necessary cleaning crop, which the farmer had to face. Beet was the best cleaning crop he had ever come across. He did not say that beet could be grown at a very large profit, but certainly at a profit, even taken by itself. That at once rendered profitable wheat production possible over a very large acreage, where profit was so problematical now, that it was not worth the farmers' while to speculate by putting grassland back under the plough. Beet cultivation involved a far greater use of artificial manures than was common practice with any other form of cleaning crop, and a very considerable proportion of those artificial manures remained at the end of the beet crop as unexhausted manurial value in the soil when the white straw crop followed. That had been seen with the barley crops in the Eastern Counties which had followed the beet crops grown for the Cantley factory. Another substantial advantage was that one cultivated at a greater depth for beet than for any other ordinary cleaning crop. The subsoiling should be done to a depth of 14 inches; below that there was a deep aeration of the soil from the extraordinary long and persistent form of tap-root which the sugar beet threw out.

Mr. C. SANDRACH PARKER, speaking in support of the resolution, said that in every one of the tropical possessions of the British Empire, there was suitable land for the production of cane sugar. The industries of this country required a cheap supply of raw sugar and a supply which should not be artificially cheap and liable to be artificially dear, but a supply which should be naturally cheap and drawn from a large enough area and from a sufficient number of sources to make it likely that the competition between those sources would prevent any violent fluctuations in price. America, many years ago, had seen the advantage of developing her own sources of supply in sugar, and the marvellous development that had taken place in Cuba since the Spanish-American war showed the effect that it had. This year Cuba was expecting to make over 2½ million tons of sugar, whereas their crop was reduced to 250,000 tons at the time of the Spanish-American war. The British Empire could do exactly the same. He had suggested that it was impossible to develop the sugar industry either in Great Britain or in the British Colonies for the supply of the British market, unless there was some security in the British market that they would not be met with and drowned out by the dumped surplus of foreign markets. All their competitors had their own markets secured to themselves, walled in by high tariffs. They charged their own customers their own price, and they produced on a very large scale, which cheapened the cost of production, dumping their surplus over here as being the only country in the world, with the exception of Turkey and Persia, that would admit sugar free. The Colonial producers of sugar had been practically shut out of the United Kingdom for 35 years past. He had proposed that they should establish a preferential tariff between their imports of foreign sugar, and imports of British grown sugar. His idea was that they should impose a duty about the same as that imposed in the South African war, namely, about a ¼d. per lb., and that the British Colonies should come in at a considerable preference, there still being a slight margin of duty against it as compared with the beet sugar production of this country; he believed the odds against which the beet sugar industry in this country had to contend at the present time, required Government assistance to establish that industry on a sound paying basis.

Mr. W. T. CHADWIN (Secretary, the British Sugar Beet Council) said that every year two million

tons of sugar was used in this country, so that the relative amount of sugar that the beet growers would produce here was exceedingly small. They had no chance of growing anything like two or three million acres of sugar beet. They could grow a sufficient quantity to produce sugar that would steady the market, and would probably to some extent lower the price. At present the rate of increase in the consumption of sugar throughout the world averaged about three-quarters of a million tons a year, and the total consumption of sugar practically doubles in from 20 to 30 years. That meant that they were in measureable distance of requiring sugar from half a million acres of land added every year to the previous year's production. Looked at from that point of view, he thought there was ample evidence that they ought to begin producing sugar of their own. In recent years France, which at one time exported large quantities of sugar to this country, had practically ceased to be an exporter. Germany used to export three-quarters, or rather more, of her total production. Of recent years she had more than doubled her home consumption, and had reduced her exporting surplus to one-third. Russia had never exported any large amount of sugar to this country: he believed that in five years she had only exported about 140,000 tons, and that only when prices were abnormally high. So that he thought the bogey of surplus dumping from the Continent was disappearing. At the same time he most fully agreed that this country should have some means of securing to itself a stable market. He thought they might have a preferential duty such as Mr. Parker suggested until they were firmly on their feet. He believed the manufacturers could produce sugar in this country as cheaply as anyone could do on the Continent.

Mr. BUCKMASTER (London & South Western Railway) said that his Railway Company had started a campaign through their own territory with a view to inducing farmers to take an active interest in the beet question.

On the motion of Dr. ORMANDY the discussion was adjourned.

At the meeting on March 1st the discussion was resumed, with Prof. Hodgkinson in the chair.

Dr. W. R. ORMANDY said that in 1890 the price of sugar in Germany was about 5d. per lb. on the average for small quantities. That meant, he believed, that whilst beetroot cultivation was being developed in Germany, and beetroot was giving 7 to 8% of crystallisable sugar instead of 17 or 18% that was now obtainable, the German people were being penalised to pay for the development of that industry. On the other hand, a great number of the industries which we in this country had been able to bring to a very high degree of perfection, such as jam and sweet making, confectionery and cakes, could not be developed by the Germans, because owing to the fact that we got sugar from Germany at a price which was a quarter of that which the German population was paying for it, we had become the largest sugar consuming nation in the world. The average consumption of sugar per head in this country was about 110 grms. per day, about a quarter of the total amount of carbohydrates necessary for the average human consumption. If the whole of the German nation were willing to pay 5d. a lb. for sugar in order that they in England could get it for 1¼d., there was something to be said for accepting this sacrifice of the German population for our benefit. Again, with 40 million people we could not possibly make what 80 million people had been making. That being so, a certain amount of selection had to be exercised; and the question that had to be considered was whether the cultivation of beetroot was the most profitable, or one of the most profitable, directions

in which to work. Captain Courthope had omitted to put a very considerable number of further advantages that would accrue from the growing of beetroot, such as, for instance, the possibility of recovering considerable quantities of potassium from the schlempe, and that industrial alcohol could be made from the residuals at a very low price.

Dr. E. J. RUSSELL said that all the experiments made at Rothamsted and elsewhere in connection with the growth of sugar beets, had shown conclusively that they could be grown profitably in this country at the price offered by the factories, viz., 25s. per ton. But there was a difficulty owing to the scarcity of casual farm labour. The main advantage of growing sugar beet was that it introduced greater diversification into farming. The advantage which could be shown to have accrued to German and French agriculture in the growth of sugar beet lay largely in this fact. It would be a relatively simple matter to put in sugar beets, and there would be distinct advantages to British agriculture through the general introduction of another crop of that sort. But the difficulty was that a sugar beet factory required a large supply of roots and was not able to work on a small scale. Owing to difficulties of transit, that meant that the farms near the factory had to concentrate themselves on sugar beet, and produce it in very considerable amounts. The farmer could grow sugar beet so long as it was only going to be subsidiary, but no large scale experiment had yet demonstrated that it would be worth his while to scrap his present main product and take sugar beet as his main industry instead. Mr. C. S. Orwin, of Oxford, had showed recently that in the districts under investigation in Norfolk the cost of growing sugar beet was somewhere about 21s. a ton. The price paid by the manufacturer was 25s., which left a profit of 4s. Taking the crop at 10 tons an acre, that was a profit of £2 per acre, which was not big, and not sufficient to induce a man to give up a business he understood and take on a business he did not. As to the possibility of growing sugar beet on waste land, such land was extraordinarily difficult to deal with; as a rule if land lay waste, it was because it had never been worth the while of anybody to enclose. Examination of the soils of commons showed that the land left to the public was land on which nothing could profitably be grown in the old days. In the time of the Napoleonic wars wheat was selling at well over 100s. a quarter, and it probably did not cost more than 40s. to grow, so that the temptation to enclose land was enormous. The agricultural value of waste land might be gauged from the fact that it did not get enclosed, even in those days when wheat was at that high price. A man who owned waste land might let it for shooting, and also arrange to let it for a low type of agriculture; but if he converted it into agricultural land, he would want a total rent which was at least equal to the two rents he had previously got, and sufficient in addition to repay the amount he had spent on it.

Dr. L. T. THORNE said that he was greatly in sympathy with the resolution in the main, but this discussion had resolved itself into a cloak to support an attempt to create artificially in Great Britain a large production of beet sugar. Beetroot could only be cultivated on really good soil, or else the development of the soil would cost far more than the value of the beet cultivated on it. Again, if a factory were to deal satisfactorily with the production of beet sugar, it must deal with it on a large scale, and it must deal with beetroot grown within a reasonable distance of the factory. In Germany, Holland, Russia, and France, where the beetroot sugar industry had developed in a fairly satisfactory way, there were very large tracts

of land suitable for this cultivation. In England there were not those large tracts of land. There might be considerable tracts in Lincolnshire, and parts of Suffolk; but even there they were not so large or available as to be converted with advantage to beet sugar cultivation. In the Continental countries where beet sugar growing was carried on to any extent, the rotation was in all cases three, and in most cases four years; so that three to four times as much land must be under cultivation as would in one year produce the amount of beet necessary for the economic working of the factory. Then the climatic conditions were less consistent in this country than they were on the Continent. For beet sugar cultivation they undoubtedly wanted both a satisfactory amount of sunlight in the course of the growth, and a satisfactory amount of moisture. The beet sugar industry on the Continent was not the great money-making thing it was supposed to be. It had been developed largely at the cost of the inhabitants of those countries by the duty imposed. The cost of refined sugar in Paris 15 or 16 years ago, within half a mile of the factory where it was made, was 6d. per lb., and that same sugar was to be obtained at the same time on the London market at 1½d. There was therefore an artificial bolstering up of the industry for a very long time. In the large beet sugar districts of Prussia, they had a very intense and scientific cultivation of the soil for the different crops. The rotation of beet cultivation necessary was one where during part of the year the true agricultural work was predominant, but at other parts of the year the factory part was predominant. In Germany they had workmen accustomed to an interchange from farm labour to factory labour, an interchange which in England was quite unusual and would be very difficult to create. In addition, the dairy side of the beet sugar works was a very important item indeed; and it was that careful and thorough combination of industry which had made it successful in Germany to a considerable extent, but even then only at the cost of the inhabitants of the country. He therefore felt that conditions in England were not such as would allow of the commercially successful cultivation and production of beet sugar. He doubted whether, if they could balance up their losses and gains, even France and Germany had made much out of the beet sugar industry. On the other hand the growth of the sugar cane might be extended in many parts of the Empire to such a degree as to go far towards supplying the needs of the Empire.

Professor H. E. ARMSTRONG moved that the resolution be discharged. He thought the Society was not competent to go forward with such a resolution. It was not a resolution which dealt with the chemistry of the subject but with a purely economic and political question and one of expediency. If they were to act in matters of that kind, they must act with extreme circumspection.

It had not been shown that it was possible both to grow beet and manufacture beet sugar, on any scale, in this country and to overcome the labour difficulties, or that the by-products could be made use of. It was only by making use of the by-products that the industry was carried on satisfactorily on the Continent. There was no comparison possible between Germany and the United Kingdom. Germany was quite right in growing beet for the purpose of getting sugar, and she must continue to do so as long as she had not countries at her disposal in which she could grow sugar cane with advantage. France, again, was in a different position. Both countries were under conditions which made it possible for them to grow beet from year to year with advantage. They had Continental climates, whereas we had an island climate. In this country, it was never certain

what the percentage of sugar would be; the beet was always coming to the stage of ripeness and then beginning to grow again, so that if they could not pick it at one particular moment, the yield might go down to a very considerable extent.

Having seen something of the sugar industry in the Southern States of America, in Queensland, in Java, and in India, he had definitely come to the conclusion that, as far as the British possessions were concerned, sugar ought to be made under tropical conditions; and that under the conditions of labour which obtained in this country, it would be altogether uneconomical on their part to undertake the growth of beet for the purpose, bearing in mind that the margin of profit was very small and that they could not afford the ground for the purpose. There was not the least doubt that farmers could grow crops, with very great advantage, which would be much more valuable to them than beet, if they were not so conservative. He thought it would have been of advantage if a resolution of this kind had been carried after the matter had been gone into with absolute thoroughness, so as to place the matter before the Government; but unless some very serious pressure were brought to bear, such as an absolute failure of the sugar supply would afford, similar to that prevailing in the case of dyes at the present moment, it was obvious that it was useless to go to the Government. In India particularly the sugar industry was in a very primitive state of development at the present time, and there was not the least doubt that the output might be far greater. Java was making 1½ million tons a year at least, but Java had a population of over 30 millions, and labour was worth 5d. a day at the outside. Those were conditions under which it was possible to make sugar. The crop in Java was a good one on the whole; the factories were well worked and had good machinery; growers were now aiming at obtaining better results by using improved varieties of cane and so on. But nothing of that kind had been done yet in India. At the present time, the sugar in India was produced largely by native methods; so that they did not know what India could do, and there was no doubt a great work before the Government of India to improve the sugar industry.

For the various reasons he had given, it seemed to him it was impossible to go forward at the present time with a resolution of the kind before him, and he therefore moved the "Previous Question"—in other words, that the motion be discharged.

Mr. T. C. CLOUD pointed out that the resolution was a question of the production of sugar within the Empire, and the discussion had resolved itself into a question as to whether they could grow sugar beet in England. They ought to know more about the possibilities in the other parts of the Empire which were making sugar; for instance, Queensland could produce very much larger quantities than she was doing.

Mr. E. J. BOAKE asked whether there was any reason why as long as Continental countries were prepared to pay us anything from 1d. per lb. upwards to consume their sugar we should take any steps to alter the *status quo*. We had many suppliers of sugar, and the price was thus kept down by competition amongst themselves.

Mr. REID said he thought the English climate was the best in the world. Continental beet growers had their disadvantages. When he was in Silesia, where an enormous amount of sugar beet was grown, a frost had come weeks before it was expected, and great efforts had to be made to get the beetroots in before the evening. He believed that the beet was originally a root which grew on the sea shore, and was therefore accustomed to moisture.

Mr. C. SANDBACH PARKER said that the European beet sugar industry had been built up in countries without any particular natural advantages, entirely by the efforts of the Continental Governments, and he could not believe that those countries had suffered by creating this industry. On the contrary, he was satisfied that they had benefited immensely, and that the British Empire could benefit in the same way by adopting a somewhat similar course within its borders.

As regards the beet sugar industry in this country, he agreed that it was a very serious thing to ask farmers to substitute beet for their main crops. But there was also the question of the capital required for the necessary sugar factories. This involved by far the greatest expenditure of all. It would be difficult to induce the capitalist to invest money for that purpose when there was the possibility that the farmers would not supply the necessary raw material. If this country required a cheap supply of sugar, in his opinion they must develop the sugar producing industry within the Empire, and add the Empire to the number of countries competing to supply it. They here had to consider whether this was not a favourable opportunity to do something to encourage the extension of an industry which already existed to a fairly large extent in various parts of the Empire. He believed that within the British Empire they could produce sugar as cheaply and as well as it could be produced in any other part of the world. What was wanted was some inducement to put capital into the factories necessary for its production, and sugar producers were not disposed any more than the aniline dye people to find the capital, unless they knew they were not going to be exposed to the same kind of competition after the war was over as they had been exposed to before.

Dr. BERNARD DYER said he did not think the growth of sugar beet would mean the imposing of another main enterprise on English farmers. It would mean no fundamental change in the work of the farm, except with regard to labour at a certain season of the year. With regard to waste land, he said there was no suggestion that the area of arable land should be increased in order to grow beet. The English farmer now grew roots once in every four years on his arable land, so that one quarter of his arable land every year was under root cultivation. The question was whether it would not be to his advantage in suitable localities to grow beet, not as an additional crop, but in place of root crops which he already grew, such as turnips and mangolds. As Dr. Thorne had said, beet growing on the Continent was associated with very high dairy farming. To make up for the mangolds or swedes which otherwise would have been grown, the farmer would get the beetroot pulp back from the factory, and would use a certain quantity of the molasses from the factory. Those two things together enabled him to keep up his farm stock. There was plenty of land in the country where excellent beetroot could be grown. The point was, whether it would pay the farmer at the price which a factory could afford to give him. He could not see why the farmer should not grow beet as a rotation crop, if there was any facility for getting it to a factory within a reasonable distance.

Mr. EASTICK said the discussion had developed into one regarding growing beet in England. In his resolution it was the Empire that was considered. But he failed to see that there was any Society in the country which could deal so impartially with the subject, because they were made up of all branches of industry.

On Professor Armstrong's motion, viz., "The Previous Question," being put to the meeting, it

was carried by 25 votes to 7. The original resolution was therefore not put.

Mr. EASTICK adds in a subsequent communication that the main object of moving his resolution has been secured. The cane and beet sugar sections have joined hands in public, and as these representatives are the leaders they have practically solved the most difficult problem to be faced—that is, to secure combined action and a uniform platform.

### Manchester Section.

*Meeting held at the Grand Hotel, on Friday, March 5th, 1915.*

MR. JULIUS HÜBNER IN THE CHAIR.

#### CHEMICAL EXAMINATION OF GHEE.

BY KAPILRAM H. VAKIL.

Indian ghee is a form of clarified butter obtained from cow's milk or from buffalo's milk. Ghee from the latter source is generally and extensively used in India, but it has only been examined twice. Lewkowitsch, in his chapter on butter fat, has given two observations on buffalo fat by Pizzi and Petkow. Similar work has been done by F. Strohmer and W. Fleischmann, but these observations refer mainly to Egyptian and Bulgarian buffalos. In 1910 Bolton and Revis contributed a paper to the Analyst (Vol. 35, pp. 343—345; see this J., 1910, 1076); three samples were examined, but it is not stated whether they were made from cow's or buffalo's milk. A. Kesava Menon (this J., 1910, 1428) gives the results of analyses of cow and buffalo ghee, but it seems that only one sample of each was examined.

A summary of the results of these authors is appended:—

Author.	Sample.	Butyro-refractometer 40° C.	Saponif. value.	Reichert-Meißl value.	Acid value.
Bolton and Revis	1	41.4	22.8	30.58	—
	2	41.4	22.8	30.42	—
	3	41.5	22.9	31.50	—
Menon	Cow	40.6	21.8-25	25.70	1.49
	Buffalo	44.5	20.6	18.21	2.00

The author has examined a number of samples obtained from different ghee-producing districts. The following table represents the analytical results of ten typical samples:—

	Butyro-refractometer at 40° C.	Saponification value.	Reichert-Meißl value.	Acid value.
(1) Bombay A. ....	44.0	23.2	23.98	1.67
(2) " B. ....	44.2	22.8	23.43	2.24
(3) " C. ....	—	22.6	21.87	1.08
(4) " D. ....	34.3	23.0	23.10	1.67
(5) Porbunder A. ....	45.0	23.0	23.76	1.68
(6) " B. ....	44.8	21.8	20.46	2.57
(7) Surat A. ....	43.5	22.7	25.30	1.71
(8) " B. ....	44.0	23.0	24.53	1.40
(9) Bulsar A. ....	45.0	22.4	22.11	3.63
(10) " B. ....	—	22.0	21.78	2.89
Average .....	41.55	22.6	22.65	2.11

Sample (4) was specially prepared for analysis. The acid values are not oleic acid values.

From these figures it will be seen that the principal difference is in the Reichert-Meißl values, the highest recorded being that of Bolton and Revis, viz., 30.80, and the lowest, 18.24, by Menon. This abnormally low figure was explained in the discussion of Menon's paper, by Bolton, who suggested that the sample was heated until quite free from water and might have been over-cooked, whereas the manufacturer, whose object was to obtain the minimum loss, would heat it just sufficiently to drive out the water and thus often under-cooked it.

There is no doubt that the samples from the manufacturers are under-cooked, but it was surprising that it should make such a difference in the Reichert-Meißl values. The results obtained by the author are within fairly narrow limits, the highest being 25.31 and the lowest 20.46. This may indicate that the commercial samples are uniformly cooked.

Menon's paper also shows an abnormally low figure for saponification value, viz., 20.6.

The acid values, obtained by the author, if converted into oleic acid values, will be found to be very low. This is quite natural, as the samples examined were all fresh. The high values obtained by the previous authors are due to their samples being old.

### Nottingham Section.

*Meeting held at University College, Nottingham, on Wednesday, February 24th, 1915.*

MR. JOHN WHITE IN THE CHAIR.

#### GRINDING AND CRUSHING MACHINERY.

BY M. A. CROSBIE.

Presumably the first method used to powder material was to lay it upon one piece of rock and hit it with another, possibly choosing a hollowed out stone for the bottom, to prevent losing the material. This method remains to-day in the pestle and mortar of the pharmacist.

Another method adopted by prehistoric man, and still in daily use, is that of rubbing the material between two flat stones. This remains in its original form in the more primitive parts of the world as the quern, where two flat discs of stone are used, the upper of which (having a central hole through which corn is fed) is twisted with a semi-rotary motion with a stick handle. It is in every-day use in India and Africa, where one native squats working the stones, while another drops in the corn grain by grain, and it is this type referred to in the Biblical phrase, "two women grinding at a mill." Its more modern equivalent is the horizontal mill, and this was until recently the only mill used for preparing flour.

Another method consists of crushing the material by rolling a cylindrical stone over it, as exemplified by the edge runner, where the stones roll over a flat bed, and the rolls, where two rollers run together crushing the material between them.

Of course metal has often been substituted for stone, but these three methods remained the only means at our disposal, until the introduction some forty years ago of the "percussive" grinder or "disintegrator." Here the material to be powdered comes in contact with rapidly revolving arms or beaters, and is ground by reason of its

inertia. The underlying principle of all these methods consists of stressing the material by applying either a compressive or a shearing strain, or a combination of the two.

Proceeding now to describe each method more fully, noting the different varieties of each type, there is first the *pestle and mortar*, the hand variety of which is familiar to all, whilst for little jobs just too big for hand the mechanical mortar is employed, where the pestle is rotated by machine, being loaded with weights to suit the material, and sometimes given a spiral path in the mortar. Or the pestle may have a rotary path and the mortar a reciprocating motion.

The stamp mill is another variety of this type; here the pestle is lifted by machinery and dropped by gravity, by means of a revolving arm engaging with a flange on the stamp rod, this arm giving a twist to the stamp rod as well as lifting it.

The *stonebreaker* really belongs to this class. Here a crank or eccentric rocks a chilled iron or manganese steel plate, crushing the material between it and a stationary plate, which latter can be adjusted to give any desired opening at the bottom through which the crushed material drops.

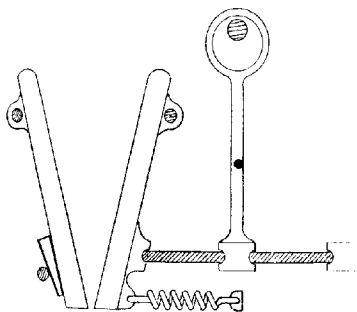


FIG. 1.  
Stonebreaker.

Fig. 1 shows a simple type which, however, suffers from the defect that some materials tend to slip up again rather than receive the full nip, but this defect can be overcome by compounding the motion or altering the fulcrum position.

*Gyratory crusher.* Another type of rock breaker, more rapid than the "stonebreaker," but yielding a less regular product, is the gyratory crusher, again an adaptation of the pestle and mortar, where the pestle has a motion akin to that of an expiring peep, inside a fluted mortar open at the bottom to allow the exit of the crushed material.

The second method, that of grinding between two flat surfaces, exists as the quern, already mentioned, and the *horizontal or flat stone mill*, which consists of two stone discs, one of which (usually the upper) revolves, while the stock to be ground is fed through a central hole in the upper stone. These stones vary from soft Derbyshire grit stone to the hardest French or German buhr (a quartz). These latter are built up of wedge-shaped pieces cemented together, with iron binding hoops shrunk on, and a backing of cement and small stones to give extra weight. These stones are dressed by cutting groves or "furrows," the shape of which varies considerably with different classes of work. Specimens of dress are shown in Fig. 2, and a sectional elevation of a mill in Fig. 3. Both top and bottom stones are dressed alike while lying side by side, so that when the top stone is inverted and in position the furrows lay across one another, and when running give a scissor-like

action to the "land" or grinding surfaces between these furrows. The furrows have a steep back, but run off to a feather edge in the direction of

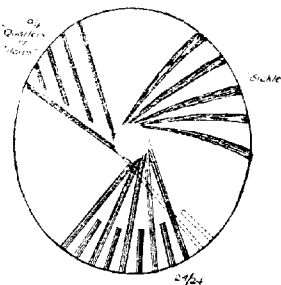


FIG. 2.  
Specimens of Horizontal Millstone Dress.

travel, up which the stock rolls; it is then swept forwards by the running stone, gets nipped between top and bottom land, falls into the next furrow, and so on, all the time working outwards by centrifugal action, pursuing a spiral course until it reaches the edge, where it is swept round to an opening, and so leaves the mill. The safety of a

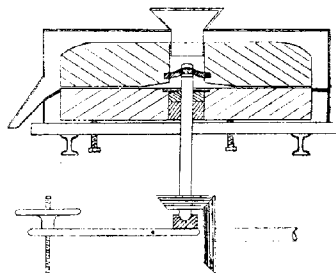


FIG. 3.  
Horizontal Mill.

built-up stone depends entirely upon the shrunk-on rings, and if these, by attrition or rusting, become weak, they must be replaced, and also care must be exercised to prevent these mills racing, about 120 revs. per minute being the normal speed of 4 ft. or 4 ft. 6 in. diameter stones. Care must also be exercised to prevent these mills running empty, for besides damaging the faces, wearing away the dress, they might set fire to the material lying round the outside, which is a grave risk in a flour or rice mill, as here the spouts from the mills are connected to a stove room filled with cereal dust and air, a highly explosive mixture. A flame started by sparks from a mill running empty travelling up the spout and firing such a mixture, has wrecked many a mill.

Variations of this mill are legion. The grinding surfaces are sometimes made of an emery or other hard composition. Fluted chilled iron plates are often used, and are sometimes made conical instead of flat, fitting one within the other. The domestic pepper mill is a minute specimen of this type. Such composition or iron mills are more often turned on their side, so that an outside bearing can be easily fitted. A diminutive specimen of this type is the coffee mill used in provision shops. These lead up to another variety of iron



mills, having annular teeth instead of tangential grooves, but these are best considered when dealing with disintegrators.

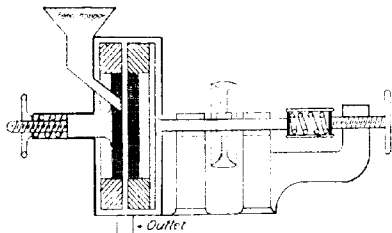


FIG. 4.  
Combined "Stone" and Iron Vertical Mill.

"Edge runners" or "chasers." Here two stone discs roll round on a flat bed as shown in Figure 5. The stones used in this country are usually grey Aberdeen granite, varying from a few cwt. up to three tons or more apiece, very occasionally even six tons each. It will be noticed that while both the outer and inner edges of the runner must of necessity travel at the same rate, yet for each

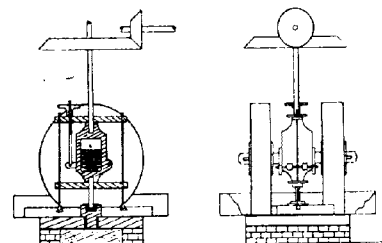


FIG. 5.  
Edge Runner—Side and Cross Sectional Elevations.

revolution round the bed they have covered different length paths on the bedstone, so that runners and bed are not in simple rolling contact, a twisting motion being set up, and the nearer the stones are to the centre the greater is the difference

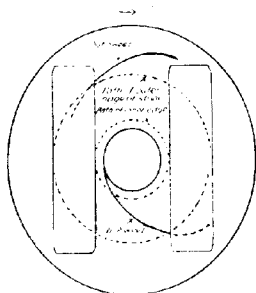


FIG. 6.  
Plan of Edge Runner. Showing Insweep and OutswEEP position and path of stones.

between the two paths; consequently the twisting action is increased, and with it the efficiency of the mill. For rough work, such as mortar mixing, iron is substituted for granite, and it is then the pan which revolves, and the mill is usually under-driven.

Two scrapers or "sweeps" are fitted, one to carry the material under the stones and the other (which can be raised or lowered at will) to throw the material out when sufficiently ground. Provision is often made for lifting the cross shaft and so relieving part of the weight of the stones off a material which would otherwise clog, whilst occasionally the stones are tapered, making the circumference of the stone equal or proportional to its path, thus eliminating the twist and leaving only the rolling motion; this is, however, unusual and only used for special work. These mills are used for a variety of articles, *e.g.*, drugs, chemicals, minerals; even such substances as lead or aluminium can be ground to a fine powder in a mill with 5 ft. 6 in. or 6 ft. diameter stones weighing about two and a half tons apiece. They are also used in many trades for crushing and kneading, such as cider apple pulping, clay kneading for pottery and brick making, mortar mixing, *etc.* For paint and ointment mixing these mills are apt

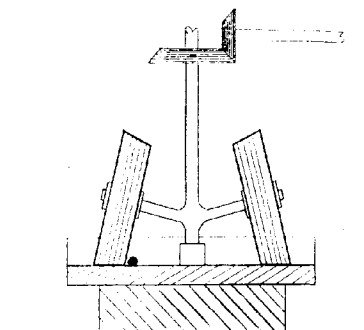


FIG. 7.  
Special Edge Runner giving Rolling Contact only.

to skid, pushing the material in front of the stones instead of rolling over it, so a bevel wheel is sometimes made fast to the toe-pot or vertical shaft bearing housing, meshing with bevel wheels fastened to the sides of the runners, so that the stones cannot rotate without revolving. The author has seen one of these mills used for grinding and levigating earth colours, such as rouge, where an impalpable powder was required. The mill was entirely submerged in a tank of water, a steady stream of which, admitted at the bottom, caused a continual overflow carrying away to a settling tank those particles light enough to float. Fire risk with these mills is practically non-existent. The stones are usually secured on the cross shaft by cotters strong enough to withstand the end thrust at their normal speed of 14 to 19 r.p.m., but it is as well to make sure that they will stand the increased strain due to accidental racing.

"Rolls" are used where one "bite" is sufficient, as in linseed crushing, where prolonged pressure would start the oil, making a greasy mass. They consist of two chilled iron or porcelain rollers, sometimes of equal size, sometimes one large and one small, either plain or, if there is any difficulty in getting a grip on the material, fluted or spiked; whilst for crushing material such as sugar cane they often resemble spur gears, but are very wide compared with their diameter. Sometimes the rollers are compounded, being four or five high, the material passing between the first and second rolls, back again between second and third, again between third and fourth, and so on; this method is adopted for paint rolling and also for seed crushing before pressing for oil. Another method of adding to the efficiency of rolls is to supplement their

purely crushing action by reciprocating one or both of the rollers laterally, or by passing the material between a single roll and a shaped block, which is

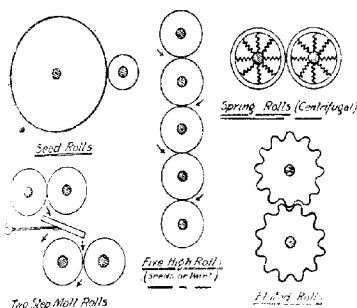


FIG. 8.  
Rolls of various types.

continually moved backwards and forwards across the face of the roll. This gives the required combination of compression and shear necessary for fine grinding.

Occasionally it happens that to crush a seed so that every particle is fine enough for use entails the softer part being too finely crushed; this occurs with malt for brewing, and in this case the grain is given a preliminary nip through one pair of rolls, falling on to a sieve which separates the fine, while the coarse passes over the end of the sieve and through another pair of rolls, giving a much harder nip, crushing the rest sufficiently. With rollers running at equal speeds the material is only subjected to a squeeze or nip which tends to flatten out a soft material rather than reduce its size, so differential rolls are used, where one roller revolves faster than the other, imparting a rubbing as well as a flattening action. Again, these rollers may be either plain or grooved, and it is these fluted differential rolls that have of recent years displaced the horizontal for flour grinding. The horizontal mill grinds all the constituents of the wheat berry together, but the consensus of opinion is that the husks and germ are best removed, so that after cleaning (a process involving sifting and winnowing to remove stray seeds, stones, chaff, etc., knocking about to break up lumps of dirt, soaking in water to wash and

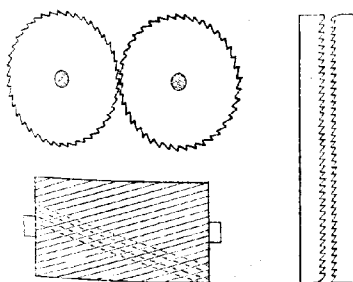


FIG. 9.  
Fluted Differential Rolls.

toughen the husk, brushing with rotary brushes to help remove the dirt, drying, and passing over a magnet to remove any stray iron), the wheat is subjected to treatment designed to liberate the

flour from the husk and germ, at the same time keeping the cells unbroken as far as possible. This is achieved by the use of fluted differential rolls of the type shown in Fig. 9, where the size of fluting is exaggerated for the sake of clearness. These grooves are cut at an angle of about  $15^\circ$ , as shown, and give a scissor-like cut, and are so shaped as to leave a series of teeth (from 8 to 40 per inch, according to conditions) on the face of the rolls, with one straight and one sloping edge like saw teeth. Both rolls of a pair are cut to the same hand, so that when in position the teeth are face to face, both rollers running inwards and so in opposite directions. Now if the roll with teeth facing forwards is the fast roll, it overtakes the sharp faces of the teeth on the slow roll, and the teeth pass face to face, setting up a sharp cutting action accentuated by the guillotine or scissor action, due to the grooves being cut spirally and lying at an angle of  $30^\circ$  to each other. If it is the roll with the teeth set backwards that is the fast one, it overtakes the teeth on the slow roll from their back, and the teeth thus pass back to back, setting up a rubbing or squeezing action.

This can be clearly seen in the figure, where two saw blades have been substituted for the rollers. Both these actions are made use of, the latter method being adopted in the first "break," where the wheat is subjected to a light nip, sufficient only to burst it open, and liberate the "crease dirt" being, as its name implies, dirt contained in the fold or crease in the skin which cannot be removed by any preliminary cleaning. To prevent the large grains being unduly broken, or the small grains not being sufficiently crushed, this first break or reduction is performed in two machines, the wheat being graded and the larger grains passing through one pair of rolls set wider apart than the pair through which the smaller grains are passed. Grooved differential rolls must never touch or the teeth would be spoilt; they are carefully set to the requirements of the stock passing through. In the first break the teeth are parallel to the axes of the rolls, so that there is no scissor action. The stock from these two pairs of rolls is passed to a "scalper" or sieve to remove this crease dirt, and the coarse crushed wheat is passed on to the second break, where the first-mentioned method is used, which lightly detaches flour and germ from the husk. From here it goes to another scalper and the coarse particles pass on to the third break where the process is repeated, and so on through a fourth (and perhaps a fifth) break, by which time the husk has been entirely separated from the flour and germ. This process is sometimes completed in four breaks, and sometimes extended to six. The method adopted to separate the germ clearly shows the difference between differential and equal speeded rolls. The "chop" or fine crushed stock sifted out after the second and subsequent breaks is sifted collectively or separately, according to requirements, into "semolina" and "middlings," and the various products are separately run through equal speeded smooth rolls, which, while reducing the starchy matter to a uniform product, flattens out and increases the size of the soft, oily germ, which is then sifted out and the flour finished off by a final grinding between smooth faced differential rolls.

The sifting or "purifying" is a complicated process involving both sifting and aspirating, but no grinding principles.

**Centrifugal rolls.** Here the rolls consist of metal sleeves, or tyres, held in position on their shafts by radial springs, instead of being solid. A large lump passing through attempts to displace the shell, and should the combined effect of spring and centrifugal force be sufficient the lump is crushed (a stray hammer head which would wreck a jaw crusher would

pass through without damage). Obviously the faster these rolls are run (within safe limits) the more powerful they become, yet there is no need for them to be run faster than is required just to crush the material, hence the speed should be adjusted to suit each job to obtain their highest efficiency.

The next type of roll to consider is entirely different in construction but may also be called the centrifugal roll. Here a pair, or sometimes four, rollers working in slotted arms fastened to

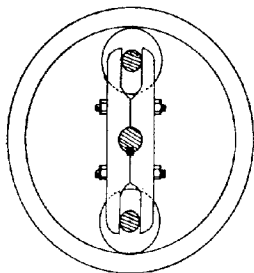


FIG. 10.  
Centrifugal Rolls.

a shaft, are rotated inside a stationary ring against which they roll, being held out by centrifugal action. Steel rollers are used weighing about 60 lb. apiece, travelling at about 300 r.p.m. inside a steel ring 2 ft. internal diameter. One variety has a vertical spindle, being fed from above while the powder leaves at the bottom, while another has a horizontal shaft as shown in Fig. 10, and in this case the powder is exhausted from the mill by a fan the speed of which is varied according to the material and fineness of powder required, while steel balls are used in some types instead of

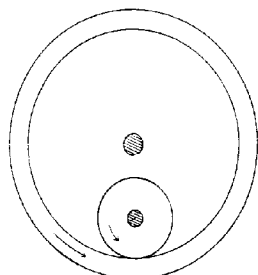


FIG. 11.  
Self-Contained Rolls.

rollers. A connecting link between this type and those already considered is to be found in a mill consisting of a small solid roll revolving inside a larger hollow roll which also revolves (see Fig. 11). This type has recently been revived and patented, with the important improvement of having the axes of the rolls set "on the cross."

This mill also forms a connecting link with another type of mill, namely the ball mill (see Fig. 12), where a cylindrical iron drum containing a number of loose rollers, balls, or sea-shore pebbles, revolves on trunnion bearings, the grinding being done between the surfaces of the rollers or balls as they move one on the other, or on the inner surface of the container as this latter is revolved. The type generally adopted consists

of an outer shell of boiler plate fitted with a renewable porcelain or quartz lining (to prevent iron taint) and about half filled with pebbles and the

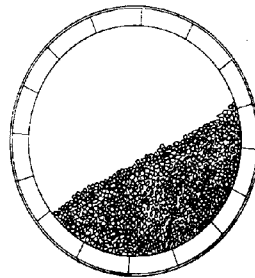


FIG. 12.  
Ball Mill.

interstice filled with crushed material; a dust-tight manhole cover is fitted and the drum set revolving for anything from a day to a week, when the stones rolling over and over on the stock grind it to powder. At first sight this does not seem a very business-like method, but in practice it works extremely well; it is dustless and requires little attention, and many materials can be ground sufficiently fine to dispense with sifting, except through a coarse grid to separate the powder from the stones. Such mills are in great favour with chemical manufacturers on the Continent, whilst for grinding the ingredients for high-class porcelain they are invaluable, being equally suitable for both wet and dry grinding and, being porcelain-lined and using porcelain balls, no possible taint can accrue. Another variation of this principle is the tube mill (Fig. 13), which is

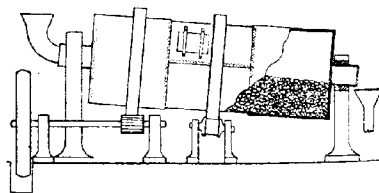


FIG. 13.  
Tube Mill—partly in section.

simply a ball mill of extreme width or length, slightly inclined and fitted with hollow trunnions through the higher of which the material is fed, and by the time the stock has worked its way to the lower end and out through the trunnion it is sufficiently ground, the rate of feed determining the fineness of the product. Such mills from 20 to 30 ft. long and from 5 to 6 ft. in diameter, containing four to five tons of pebbles, have superseded all others for cement grinding, the banks of the Thames round Northfleet being littered with old horizontal stones thrown out within the last few years to make room for tube mills. The pebbles used must be hard without being too brittle, and Belgian sea-shore pebbles are the most suitable, even being exported to America. They do not wear appreciably unless they break, when they are quickly reduced to powder which is of no consequence in cement; in fact as pebbles are considerably cheaper than cement replacements cost nothing (this, by the way, also occurs with barley ground for cattle feed in very soft-stoned horizontal mills).

Another type of ball mill, the *continuous feed and discharge ball mill*, is very similar to that first considered, except that the grinding drum is unlined and perforated and enclosed within another drum which acts as a sieve, the material being fed through a hollow trunnion; in this type the inner surface of the drum is not cylindrical but built up in a series of steps as shown in Fig. 14. The

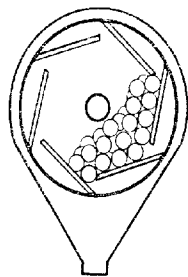


FIG. 14.

Continuous Feed Ball Mill.

action is akin to rolling the material and a number of steel balls down an interminable staircase, each tread of which is perforated, letting the fine particles through on to a sieve underneath, the finest passing through and away, whilst the larger particles are returned to the bulk a few steps lower down. The construction makes the use of steel imperative, but the actual wear is so slight as to render the iron taint negligible.

There are one or two types which form connecting links between the disintegrator and the horizontal mill. In *bar or cage disintegrators* both discs revolve, but in opposite directions, thus doubling the effective velocity without increasing the speed. The discs have a number of bars projecting from their faces, forming a number of concentric rings alternately attached to one disc or the other, as shown in Fig. 15. The material

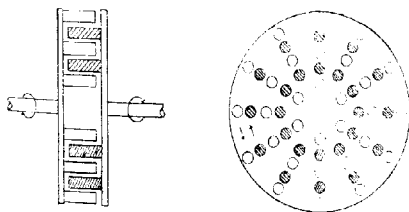


FIG. 15.

Bar or "Cage" Mill.

is fed into the centre through a hole in one of the discs, and in passing outwards is struck by the bars and knocked first in one direction and then the other, being struck by perhaps eight sets of bars before it leaves the mill. The action can best be likened to a series of squirrel cages one within the other and rotating in alternate directions; hence the name, cage mills. A mill has been designed for rock crushing in which the material was to be its own grinding medium; it consisted of two funnel-shaped discs running mouth to mouth in opposite directions, the idea being that the material (broken down in a stone-breaker) on being fed into the mill would fill up these funnels which would then act as millstones (see fig. 16).

*Eccentric disc mills.* Here one disc is smaller than the other, and has a central hole through

which the feed reaches the mill. This disc is driven, carrying round with it the lower disc, setting up a shearing action, while pressure can be regulated by raising or lowering the bottom \*

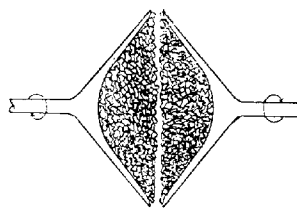


FIG. 16.

Auto-Grinder.

disc. Sometimes the top disc is convex, and the lower one concave. The *end runner mill*, which belongs to this class, is somewhat similar to, but much more efficient than the mechanical mortar (see fig. 17).

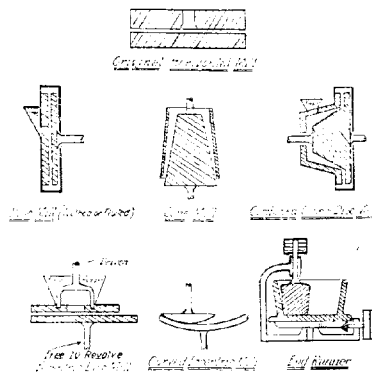


FIG. 17.

The now obsolete "*pulveriser*" had two shafts in line revolving in opposite directions, on the inner extremities of which were fitted bosses carrying arms, at the ends of which were hand plates set at an angle as shown in fig. 18,

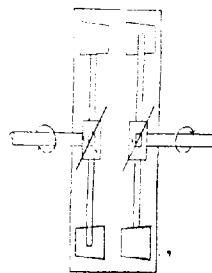


FIG. 18.

"Hand Plate" Pulverizer.

so that a particle struck by one hand would be deflected into the path of a hand travelling in the opposite direction and smashed, these smaller pieces being in turn dung back at the other set of plates and further reduced, and so on until the

particles were small enough to be carried out of the mill in a current of air. First of all the hand plates were abandoned as useless, and later one set of arms was omitted as unnecessary, it being found that the arms themselves did the grinding. This simplified construction constitutes the present day *disintegrator* as shown in fig. 19. The boss is

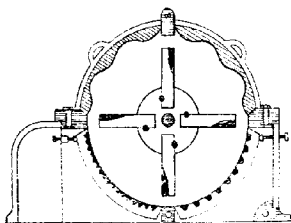


FIG. 19.  
Disintegrator.

supported by a bearing on each side instead of being overhung, as was necessary where two sets of beaters were employed, and these beaters are made of Lowmoor iron with a facing of hard steel welded on to resist wear, and fit into mortices in the boss, being secured by cotters. The fluted top is made of chilled iron and by its shape deflects the material back into the beater path, and the sides are made of the same material and also fluted for the same purpose. The powder escapes between the bars shown, which are of steel held in cast-iron frames, the gaps between the bars varying from 1 in. down to  $\frac{1}{8}$  in. according to the fineness of powder required. The mill runs at a high speed, depending on its size, all sizes having the same peripheral speed, about 3 miles a minute, and at this speed acts as a powerful fan, thus preventing blow-back through the feed intake, and the air leaving the mill through the grids or screens carries the powder with it, thus rendering a settling chamber necessary.

These mills are highly efficient and will deal with most classes of material, but unless properly erected can constitute a grave fire risk, and should be well isolated from main buildings. As an instance the disastrous explosion and fire at Liverpool in 1911 started from the breaking of a driving belt of a disintegrator when grinding linseed cake. The belt in its recoil struck and burst the dust-settling chamber, liberating the air containing fine particles of linseed cake which became ignited, the explosion wrecking and firing the factory. At least two big fires have been caused by grinding resin in these mills.

Owing to the rigidity of all the parts, this type of mill suffers considerably in the event of stray metal of any size entering accidentally, and a mill designed to obviate this has the beaters hinged and constructed without grids; the beaters stand straight out by centrifugal action in the ordinary course of grinding, but hinge back when a large mass of metal is encountered. Such a mill is useful in crushing articles such as horse hoofs, where an occasional horse-shoe is encountered which would wreck an ordinary machine, or in grinding house refuse, as is done by some municipal bodies; this consists in the main of tea-leaves, fish skins, ashes, etc., but an occasional flat iron or dumb-bell has to be reckoned with. One section of the casing is hinged and held in place by an easily opened catch, and upon the attendant hearing the noise caused by such a stray article he at once opens the catch with a long pole, standing well aside and out of the way of the ejected material. I once saw a piece of metal, which had

originally been a bolt, leave such a mill almost white hot, and become imbedded in a wall fifteen feet away.

*Multiplex disintegrators*, of which there are many varieties, have several sets of beaters mounted upon one shaft, becoming progressively larger from feed end to delivery end, the idea being that the preliminary crushing is done by the small set of beaters, and the final fine grinding by the last set, whilst occasionally a wing fan is mounted on the shaft beyond the last set of beaters to draw the powder through (see fig. 20). As a class these

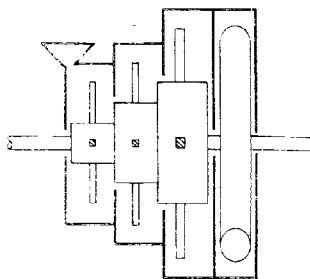


FIG. 20.  
Multiplex Disintegrator.

mills are successfully used on soft materials such as sugar, although it is questionable if they are more efficient than the single type even on such articles, but they are out of the question for the general run of work, for if one set of beaters is running at the right speed the rest must of necessity be wrong, and as considerations of safety limit the speed it is the largest which is correctly speeded and consequently the others are all running too slowly and working inefficiently, and the material only partly crushed is speeded up by one set before passing to the next, thus reducing its effectual speed. Experience shows that the larger the piece which can be fed into the mill with safety the finer the resultant powder, which is only to be expected from a consideration of the underlying principle. For instance, large pieces of liquorice root fed into an ordinary disintegrator can be ground to a fine powder, whereas crushed root would only be reduced to fine splinters, while the large pieces if fed into a Multiplex would either wreck it or hopelessly clog it.

#### DISCUSSION.

The CHAIRMAN asked what was meant by two stones or rollers being cut to the same hand. How many grindings did it require to convert wheat into white flour? Was wheat ever ground so as to produce a particular offal (sharps)?

Mr. J. T. WOOD asked what mill was used in grinding aniline colours? Was a variety of mills used or only one?

Mr. CROSBIE: A variety.

Mr. WOOD said he knew that ball mills were used because sometimes steel balls were found in the colours.

Mr. ANDREW SMITH asked if the author could suggest any way by which the flat stones could be superseded. Earth colours and oxide of iron must be ground wet: could the author suggest a mill that would do it?

Dr. CAVEN said he had always understood that metals such as lead and aluminium could be powdered better if they were heated till they were brittle. He understood Mr. Crosbie to say that they were ground cold.

Mr. CROSBIE, in reply, said the meaning of the phrase "cut to the same hand" was that both

top and bottom stones were dressed exactly alike as they laid side by side: when the top stone was turned over the furrows would be in opposite directions, so that when it was twisted round there was a scissor-like action between the stones. The "land" was the ground between the furrows. The mill with the interminable staircase was a Krupp mill. "Sharps" was a mixture of flour and fine bran thrown out because it could not be separated. About 10% of very fine sharps was produced in milling. Aniline colours were usually ground in ball mills if there were sufficient colour to justify it: in case of one or two cwt. only, it was ground in an edge-runner mill. He suggested to Mr. Smith that rock emery or composition stones might be used instead of continental quartz or English mill stones, and grinding dry, or wet ball mills. Flat stones were often used for grinding basic slag. In reply to Dr. Caven, there was no cause to heat lead or aluminium in any way. He had ground compo pipe, lead foil, and so on without any treatment. The aluminium ingots were roughly broken up into ounce or half-ounce pieces and could be ground into particles of 1/20,000 sq. inch. The temperature in the mill was never high, though it might rise locally to 40° C.

*Meeting held at University College, Nottingham, on January 27th and February 24th, 1915.*

MR. J. T. WOOD IN THE CHAIR.

#### DISCUSSION ON THE EFFECT OF THE EUROPEAN WAR ON THE CHEMICAL INDUSTRY OF GREAT BRITAIN.

The CHAIRMAN, having referred to the Government scheme for the manufacture of dyestuffs, and enumerated some of the objections to the scheme,

Mr. J. H. DUNFORD, in describing the effect of the war on bone works, said they were considerably hampered by a number of imported raw materials, such as bones and pyrites for sulphuric acid making, being put on the prohibited list by practically all European countries. Moreover in certain articles manufactured from raw materials supplied by the bone industry, they had to accept half the usual price from the English manufacturers, as this class of work was mainly in the hands of the French and Germans. British fertilizer works had been badly hit by the lack of potash mainly supplied by German mines. On the other hand, opportunities offered themselves of stimulating the production in this country of cheap potato spirit and beetroot sugar. Given a low-priced spirit and freedom from restrictions, the English manufacturers could compete in many lines with his foreign rivals. One of the cheapest raw materials for the production of this spirit was potatoes. Poor sandy land in cold and damp localities would do very well for raising those kinds of potatoes suitable for distilling. Such potatoes needed little manuring and did not prove exhausting to the soil. Ordinary potatoes contained about 15% of starch, whereas one of the varieties—the Blue Giant—suitable for distilling contained up to 25%. The growth of sugar beet was of the greatest importance to this country, and we ourselves could very easily supply the greater part of our sugar requirements. In Holland the area under beet had been nearly doubled in 10 years because it paid, and with practically identical conditions there was no reason why it should not pay England to do likewise. The Dutch grew 170,000 acres of mangolds

but they found that the deeper rooting beet with its greater penetration of the subsoil and also because of its great crop of leaves, which were either ploughed in or eaten by stock, was a steady improver of the land.

In the Netherlands, the rural population was only about one-half that of London and yet they had twenty-seven beet sugar factories—three of the largest belonged to the farmers themselves. We could not at present expect the Government to take it up directly, but the Development Commission might profitably turn its attention to the most promising opening yet offered.

Germany produced in 1913 11,607,510 metric tons of crude potash salts of which she exported about 50%. The United Kingdom consumed in 1913 about 100,000 tons. In the past farmers had bought the bulk of their potash in the form of kainit which had a high chlorine content. It was estimated that in Scotland in 1913 25,000 tons of kainit was sold as against only 500 tons of high grade potash salts. Chlorine exerted a disastrous influence on the physical constitution of the soil and on vegetation. Calcium chloride was formed, and being very soluble in water, was lost in the drainage. Chlorinated manures robbed soil of its lime. It had been estimated by Mercker that a given weight of kainit caused the soil to lose an equal weight of lime, and that therefore as much quick lime as kainit should be applied to the soil to balance the loss. The comparative cheapness of kainit before the war was thus illusory. In marshy or wet lands simultaneous application of lime was necessary, as potash salts were rapidly robbed of their acid, so that in absence of lime chlorine formed free hydrochloric acid which was most injurious to plant life. Lime was also a corrective of the secondary effects of crude potash salts to prevent nitrification in the soil. Lawes and Gilbert proved that potash salts could be replaced with good results by other salts.

Lime and gypsum released potash from soils containing hydrated silicates of alumina and potash. Free or quick lime acted as a liberator of potash in all but the lightest of sandy soils. In the Caucasus there were 24 factories producing potash from the stems of sunflowers. In 1907 14,500 tons was produced. Other sources of potash were suint from wool-washing, farmyard manure, various cake meals, fresh guano, Peruvian guano, and mother liquors from the preparation of salt from sea water. Beet sugar residues contained 1% potassium calculated on weight of roots. The spent wash was neutralised by chalk and decanted, evaporated and calcined: the crude ash left contained about 50% potassium salts. Weeds, prunings, hedge clippings, brush wood, bracken, leaves and vegetable refuse contained up to 15% potash. Thistles contained 1%; chrysanthemums 2½%, and absinth stems or fumitory 7 to 8% potash, and active steps were now being taken towards the commercial production of potash. Two hundred tons of bracken ash were being used for the first test. A ton of fresh weed should yield 20 to 30 lb. of potash—enough to manure from 1 to 1½ an acre of potatoes. Canada exported potash fertilizer in the form of wood ashes.

According to the U.S. Agricultural Dept. the Searles dried-up lake in California contained about six million tons of potassium chloride. Seaweed was used in the Channel Islands, south-west of England, and parts of Scotland, very extensively as a manure. According to Hendrick, seaweed and superphosphate gave even better yields than dung and superphosphate. It decomposed in the soil more readily than dung and had the advantage of containing no injurious seeds of weeds or spores of disease organisms such as finger and toe, etc. It should either be calcined for its ash or mixed with dung in a concrete pit. According to a report of

the Board of Agriculture for Scotland [Cd. 7564], in the U.S.A. a large company was now manufacturing potassic salts from kelp on a commercial scale. Norway exported in 1913 2521 tons of kelp ash. For agricultural purposes the seaweed ash ground to a fine powder would be a most suitable form for application to the land. Canada and British Columbia contained large deposits of granite felspars, pegmatites, and leucites estimated to contain billions of tons of potash. Norway exported in 1913 53,047 tons of potassic fertilizers in the shape of ground felspar and 32,796 tons of other felspar. Sweden in 1913 exported 37,655 tons felspar. In this Journal of October 31st, 1914, attention was drawn to a process developed by Wood and Wynants in Eng. Pat. 3185, Dec. 30th, 1857, for the extraction of potassic salts from felspar which was stated to give good results.

Mr. H. SIMPSON said that so far as the soap trade was concerned, there was not much doubt that the war had brought increased business during the past six months. The cloth mills of the West Riding of Yorkshire used some hundreds of tons of soap per week in normal times, but whilst the war had been on, these mills had been working practically continuously making cloth for the allied armies and hence had used much larger quantities of soap. The various armies and navies had also required large supplies of hosiery, and this meant a large demand for soap by the hosiery finishers in Leicester and Nottingham. He did not think there had been any diminution in the trade of soaps for household, toilet, and laundry purposes. At the outbreak of war, markets for raw materials were about normal, but during August, September, and October, prices fell to a very low level, notwithstanding that the soap trade generally was brisk. This was due to the fact that a large quantity of grease, tallow, and oil which, in the ordinary way, would have been exported to the Continent, had to be disposed of on the home market. During the early stages of the war, the only fatty materials to advance were coconut oil and palm kernel oil. A large proportion of the palm kernel oil used in this country was, before the outbreak of war, crushed from the kernels in Hamburg, though he saw no reason why these kernels, which came from West Africa, could not be crushed equally well in the Liverpool district. In July palm kernel oil could be bought at £35 per ton, but early in August it had advanced to about £52; since then it had receded somewhat, to-day's price being £47. In July caustic potash cost about £19 or £20 per ton, but quickly advanced to £50, £60, £70; to-day, however, it could be bought at prices varying from £45 to £50 per ton. He believed some was coming from Russia, and possibly some was coming from Germany through neutral countries. During the last month or six weeks all oils, tallow, and greases had advanced £6 or £7 per ton. This was due to several causes: 1st. High freights had affected the prices of all imported tallow from Australia, New Zealand, and the Argentine. 2nd. Shortage of bones in this country had reduced the supply of bone greases, etc. 3rd. The public generally had been more careful and there was not so much kitchen fat wasted as before. There had been a good demand for glycerin. The Government had been large buyers of dynamite glycerin and also commercial qualities for use in the water jackets of machine guns and motor transport waggons. Large quantities of chlorophyll were used in normal times for colouring various soaps, but there was great difficulty in obtaining supplies now, as the bulk of this material came from Germany. Prices and supplies of essential oils had remained fairly normal, but synthetic perfumes, which came chiefly from Germany, were becoming very scarce and dear.

Mr. TIMMANS said that the sulphuric acid consumption of Nottingham district was reduced during the latter part of August. The week ending August 24th it was down 30%, and by the end of the month it was down 60%, owing to the textile trade of the district being in such an unstable state. In November, matters had improved and improvement had continued ever since. The aniline dye industry required large quantities of sulphuric acid, and the Government also required large quantities in the manufacture of explosives. In face of these conditions the cost of production had increased, owing to the advanced freightage and the cost of raw materials. Lead, for instance, went up in the first week of the war and still remained very high.

Mr. B. COLLITT thought the dye industry could be set up with protection of some kind for a number of years. The dye industry in Germany was the best paying of the whole of the chemical trade.

Mr. SMITH said that the Bradford Dyers' Association, who had withdrawn from the Government scheme, had put forward a very thoughtful alternative programme in place of the Government scheme. They suggested that scientific research should be endowed and manufacturers be subsidised.

Dr. CAVEN thought the fundamental problem was one, not of tariffs, but of scientific training, and of co-operation between research chemists and chemical manufacturers. The synthetic colour industry furnished the outstanding example of the way in which Germany, to her great profit, pursued the course which we had missed because of our divorce between "science" and "business."

Mr. F. J. R. CARULLA wrote: There appears to be one cause of our failure to retain the more intricate branches of chemical industry that have so much enriched the German nation, which is apt to be forgotten, namely, the lack of workmen trained in elementary knowledge of the right kind. The position of English synthetic chemical industry regarded by the side of that of Germany seems in some respects comparable with the condition of the mechanical arts in India. Can it be supposed that Germany would have acquired her pre-eminence in the chemical field were we considering without an army of intelligent workmen ready to obey and carry out the instructions of the much vaunted chemists? We possess chemists of quite equal if not of superior quality. In a comparatively recent case where a simple open mercury syphon pressure gauge had been attached to an ammonia plant, the man in charge on the particular occasion reported that the mercury had been sucked into the apparatus, completely puzzling one as to the true conditions, for this indicated a vacuum tendency of unexpected extent. Close examination disclosed globules of mercury in corners and depressions in the neighbourhood of the instrument, showing that exactly the opposite condition had existed, viz. excessive pressure, which led to the proper adjustment of the plant.

A body of workmen sufficiently instructed in the design, use, and operation of the ordinary instruments of observation, weights, and measures, the thermometer, barometer, hydrometer, pressure gauges, and all similar instruments, especially those relating to steam and electricity, ready to obey the instructions of a superior to the very letter, these are the men that the scientific chemist needs if we are to succeed in the contest that is upon us.

Mr. J. T. WOOD said that on February 22nd he had attended a meeting of the Light Leather Trades Federation in London to discuss the question whether they should support the Government dye scheme or not. The Government would not listen to the question of protection: their hands were tied.

His firm had supported the scheme because there was not a better one before them. We in England wanted aniline colours, and unless something was done we should soon be without a supply. The general tone of the discussion was that the scheme should be managed entirely from the business side. That, however, seemed to him to be a very sad state of things.

Mr. MERRIMAN said that he understood that Germany obtained a lot of raw material from this country. If we used it ourselves their output would be limited to some extent.

Mr. WOOD said that under this scheme any surplus English raw material was going to be sent to Swiss works and they were to return an equivalent quantity of dye to this country. The rest of the raw material was to be kept at home, so that in any case Germany would get far less raw material in the future, whether the scheme were successful or not, after the war. Firms who did not subscribe to the scheme would not get any dyes while the war lasted.

### Scottish Section.

*Meeting held at Glasgow on Tuesday, 26th January, 1915.*

MR. ROBERT HAMILTON IN THE CHAIR.

### THE FRACTIONAL COLLECTION OF CRUDE TAR.

BY GEO. THOMSON PURVES, A.M.I.C.E.

The complete collection of crude tar in fractions does not appear to have received the attention which its importance justifies. Apart from the purely commercial aspect, it is worth considering how far the primary separation of the crude tar into the usual first fractions in the closed condensing system would be helpful to the reduction of atmospheric pollution. In some tar works the gases evolved from the tar are burned direct and in others passed through purifiers. In the case of direct fractionation this gas would go to augment the volume of permanent gas produced.

If the tar can be collected in the ordinary practice of the carbonising work, in those fractions into which the distiller ultimately splits it up, this would clearly be a desirable attainment provided the cost of so doing is not excessive. And considering the cost in wages and fuel and possibly transit which the primary distillation in the tar works involves, there would seem considerable scope for the successful practice of direct fractionation.

It is a well-known fact that in the distillation of tar decomposition of certain products occurs, and the content of free carbon is increased. I have distilled a sample of heavy crude tar which was liquid at ordinary temperature, but after remixing the fractions, warming and allowing to cool the product was solid, showing considerable alteration in the component products. Such a change in the tar might in some cases be beneficial but in others would be objectionable. Direct fractional collection avoids the submission of the heavy tar to the high temperatures obtaining in the still towards the end of the distillation. The object in this paper, however, is to consider the question from the carboniser's rather than the tar distiller's point of view.

In gas works practice the crude gas from the retorts is very commonly drawn through a liquor

seal in the hydraulic main and here heavy pitchy tar is deposited; later in the slow condensing main, then in the final coolers and tar extractors, and lastly in the distribution system lighter and lighter fractions are separated, in each case by cooling and frictional scrubbing. This is distinctly fractional separation of tar. Further it would be a difficult matter to get other than fractional separation. But so little is it the intent that the carboniser carefully runs his fractions into the common tar well.

It will be interesting to consider one or two factors which have governed practice in tar extraction and the effects of these on the gas, on by-product recovery, and also on the trend of development towards complete direct fractionation. Before doing so, however, I wish to refer to a point in regard to the nature and the removal of tar fog. When the fog is first precipitated in the gas it must be in an extremely fine state of division, and the question arises, how fine? In a recent descriptive paper on the "Electrical Detarring of Crude Gas" as applied at the Semet-Solvay Coking Installation, Detroit,\* the following statement is made in referring to the paper stain method of determining the amount of tar fog present in crude gas. "When the gas carries large quantities of tar mist the aspirator bottle will be full of the dense brown fog which has passed through the papers," i.e., two filter papers. In the face of this no practical tar scrubber could be expected to remove such fog completely. At the actual moment of condensation the minute drops of a liquid would all be of the same size and consist of the smallest number of molecules which could satisfy the conditions of equilibrium for the liquid state. In order to remove tar fog it is necessary to allow sufficient time to elapse for the elementary liquid drops to agglomerate to the relatively very large drops which we are able to deal with in practice. The size of the globules will be increased not only by aggregation but also by the solution in them of other vapours from the gas. I find a recognition of this principle in the work of Henry Aitken, a collaborator of Wm. Young. In the Aitken process, patented in 1874, "the settling of tar fog was promoted by sending gas at 190° F. into a very large settling chamber and keeping it there for as long as possible at that temperature."† The conclusion I wish to draw from this is that tar fog cannot be simultaneously precipitated in the gas and removed by frictional means from it.

In former years, when the candle-power of town's gas was higher than it is to-day, slow cooling of the gas was favoured as a means of keeping up this candle-power by retaining in the gas as vapour a larger amount of the illuminating condensable hydrocarbons. In the Saxon industry where lignite is carbonized for its valuable tar products we find "the cooling effect is produced solely by external air, and it is important that the vapours should pass through as long a track of tubing as possible. It has been found that if the vapours are artificially cooled (by water) in a short condenser to the same temperature as is attained in the atmospheric condenser, they still contain condensable constituents, whereas these are almost entirely absent when air is used. The most important point in the condensing process is the gradual cooling."‡ Exactly opposite results are thus apparently claimed for the same operation. As the crude gas from the retorts cools down its dew points with respect to different hydrocarbons, etc., are reached one after another, and the substances settle out as constituents of tar fog. The minute drops comprising the fog float

\* The Gas World, Oct. 31st, 1914.

† Wm. Young, an appreciation by Alfred Daniels.

‡ Shale Oils and Tars, by Dr. W. Scheithauer.



in the gas for a considerable time, depending largely on their specific gravity and the amount of frictional resistance encountered. This tar fog has a solvent action on those hydrocarbons, etc., still present in the gas as vapours provided the temperature is not above their boiling points, and it will dissolve a proportion even when the gas has not cooled down to its dew point with respect to the particular substance. If the fog remained in the gas for a sufficient time, a state of equilibrium as regards solution would be established when the vapour pressure of the substance in the fog equalled the partial pressure of the substance in the gas; hence by passing the gas through a slow condensing main where the fog-globules will coalesce and settle from the gas slowly, the gas is largely denuded of its light oil constituents as is claimed in the lignite industry. Lignite carbonising being a low temperature process, a considerable proportion of the tar produced is very light specifically, and so the fog is slow in settling from the gas. The explanation of how the slow condensing main of the gas works helps to keep the lighter hydrocarbons in the gas is to be found partly in the nature of the tar produced, but more largely in the higher outlet temperatures at which the slow condensing main is operated. By fractionally collecting the tar I found in a particular test that the gas produced was capable of carrying as vapour at atmospheric temperature and pressure all the light oil produced. The cooled gas contained 3.5% of hydrocarbons absorbable by fuming sulphuric acid. All the tar present as fog at 80° C. was scrubbed out and amounted to about 2.75% of the weight of coal carbonised, and contained only a trace of solvent naphtha. By further quick cooling and scrubbing in cold water sprays to about 20° C., about 0.13% of crude naphthalene crystals is obtained. So that by the time the gas has cooled to 80° C. about 95.5% of the tar which has to be removed by the extractors has separated out as fog. If now such a crude gas at 80° C. was passed through a slow condensing main, the fog would be steadily removed while the gas cooled relatively very little, and so the tar fog would have a much reduced opportunity of exerting any solvent action on the hydrocarbon vapours in the gas, with the result that these would be largely retained by the gas and the candle-power enhanced. As the temperature at which the slow condensing main is operated is lowered, increasing amounts of benzene vapour, etc., would be removed from the gas. It is probable, however, that at temperatures even considerably below 80° C. little benzene would be removed, for the gas is considerably below the saturation point with regard to this vapour. The principle involved is clearly the retarded cooling of the gas while the bulk of the tar fog is removed. The time occupied in the operation does not appear to be a material factor. The ideal state would be the complete removal of all tar fog before the gas reached the temperature at which the light hydrocarbons would be dissolved. This is fractional tar collection in a degree. Prof. Lewes writes "it was realised that sudden cooling of the gas and condensation at too early a period affected the illuminating power more than slow cooling. This is partly due to the tar being thrown out as a whole, while with slow cooling some of the benzene is carried away as vapour by the gas, etc."\* It is not, however, speed of cooling but rather one of time contact between tar fog and cooled gas that is the material factor. For—as has been shown above—the crude gas can be quickly cooled, and the condensable tar removed almost wholly in one and completely in two operations with prac-

tically no removal of benzene. At Granton Gas Works, the slow condensing main is on the counter current principle, and so the condensed tar has the minimum opportunity for solvent action on the gas. The slow condensing main at the Greenock Gas Works is on the direct current principle, and so the condensed tar has here the maximum opportunity for solvent action on the gas. The important point in the working of the slow condensing main is that the outlet temperature shall not be low enough to permit of the benzene, etc., being absorbed. Dr. H. Colman, when working on the removal of the heavy tar fog from the hot gas (about the year 1897), had two special objects in view—1st, to remove the naphthalene more completely from the gas in the condensers, and, 2nd, to retain more of the vapours of the light oils in the gas and thereby increase the illuminating power. To effect these results one factor which he proposed\* was to pass the hot gas through a "Cyclone" extractor. The gyratory motion imparted to the gas in such an apparatus causes a centrifugal action which is much greater in the case of the tar drops than in that of the surrounding gas owing to their higher specific gravity. The tar drops are therefore thrown to the periphery of the centrifugal separator, where they coalesce and can be drained away. With the ratio of naphthalene to light oils obtaining in those days these objects were achieved. But with the larger production of naphthalene in later carbonising practice it was found that the crude naphthalene, etc., came down in a semi-solid mass in the condensers and blocked them. In Dr. Colman's method partial tar fractionation was thus used as a means of overcoming two definite carbonising troubles.

As we would expect, the writings of William Young are rich in reference to fractional condensation of tar. In the Young and Aitken process the central feature was the analyser in which fractional condensation was carried out. No effort was made, however, to collect separately the tar fractions deposited in the different sections of the analyser. The tar was allowed to flow downwards from section to section, so allowing the gas to take up as much of the lighter constituents of the tar as possible, this being the principal intent in the process. Fractional condensation with a counter current flow of condensed products thus took the place of sending the gas and condensed products in the same direction. In an address Mr. Young gave to the West of Scotland Association in 1876 on "Condensation," he showed that to retain the highest lighting value in the gas we must keep the gas and condensed tar warm until they have physically separated, and in order that the tar particles will settle out the crude gas must be kept warm and allowed to travel slowly, and further, that the tar be allowed to cease contact with the gas only at such a temperature that it could not absorb the lighter hydrocarbons.† In other words, there must be the shortest time contact between condensed tar and cooled gas. It will be shown later that all this is effected in complete fractional tar collection. In later years, when the ratio of naphthalene to light oils in the gas had largely increased, Mr. Young abandoned the principle of the Aitken and Young process on account of the fact that when it was applied the cooled gas was saturated with naphthalene vapour. With possibly the exception of the gas produced in continuous vertical retorts, complete tar fractionation will always leave the gas saturated with naphthalene vapour when a high carbonising temperature is applied.

\* British Patent No. 4742/1899.

† William Young, an appreciation, by Alfred Daniel.

\* The Carbonization of Coal, by Vivian B. Lewes.

The failure of Brunck's direct ammonia recovery process was principally due to the presence of large deposits of tar in the saturator, resulting in a highly discoloured and unmarketable sulphate. This difficulty was overcome in the Koppers semi-direct process by cooling down the gas, then removing the tar, and after reheating the gas passing it through the saturator. Reverting to the original idea of Brunck, Dr. Hilgenstock, of the "Otto" Company, perfected his process of scrubbing the crude gas with a spray of hot tar and so completely removing the tar fog, without cooling the gas below its dew-point temperature with regard to water, then passing it through the saturator. After passing the saturator naphthalene and light oils are removed by cooling and scrubbing with creosote oil. In the Simon-Carvès direct recovery process, before the gas reaches the saturator tar is removed in two separate fractions based on their different specific gravities principally, but also partly on different temperatures. The first is removed in a "cyclone" on similar lines to that used by Dr. Colman (Messrs. Henry Simon owned the original patent rights of the Cyclone dust collector), and the second in a patent "dynamic extractor," where a much more intense centrifugal action is used and the remaining tar fog completely removed from the gas. We thus see that the success of the direct ammonia recovery process is dependent on fractional separation of the tar.

In 1907 Walther Feld proposed\* to scrub the crude gas in his patent washers successively at 160° C., 80° C., and 60° C., and so obtain as separate fractions pitch, heavy oil, and a lighter oil. He further developed his process to include the extraction from the gas of naphthalene, ammonia and cyanide, etc. His process is applied at a number of Continental gas works, but I do not know with how much success. To get the first, the pitch fraction, the gas from the collecting main is passed through heat-insulated pipes into the first washer at a temperature from 200° C. to 160° C. This latter temperature is given by Feld as the dew-point temperature of the high-boiling-point hydrocarbons constituting the pitch. The washing oil in the upper part of the washer is a solution of pitch in a portion of the next condensate, and in the bottom chambers the pitch fraction itself. Before the gas enters this washer it must have deposited an almost solid pitch containing a large proportion of the free carbon. It is difficult to see how this can be worked up with the true pitch fraction on the lines of the Feld process. This appears to be borne out to some extent by the fact that soft pitch produced by the Feld process contains only 1% to 3% of fixed carbon, which is less than is usually found in crude tar. If the crude gas enters the first washer at the higher temperature and the fall of 40° C. takes place in there, it is fairly certain that some of the fog then produced would pass this washer and so lower the efficiency of the fractionation. This difficulty would be experienced in each washer where a fall of temperature occurred. Such a procedure is in fact attempting simultaneous production and removal of fog. Feld seems to have expected, or else found, this difficulty, for he proposed to improve the fractionation and to lower the temperature of the gas at one stage by pumping into it a portion of the product extracted at a later stage. This on evaporating would leave behind some of the former fraction which had been carried forward. In this way he no doubt partially helps the fractionation.

Two years ago Dr. Davidson expressed the view that the partial fractionation of the tar by the sensible heat of the crude gas could be simply

effected in vertical retort and coke oven installations.\* He also described a method of producing in the gas-collecting main a distinct and marketable pitch fraction in addition to the crude tar, which would certainly be lower in free carbon than that obtained in ordinary practice. Briefly his method is as follows. In the collecting main of the Dessau retorts an agitator works continuously. A few minutes before the draw, tar is run into the main to a depth of 10½ inches, and when the charging of the nine retorts is complete the level of the tar in the main is brought down to 4 inches. During the ensuing carbonising period the remaining tar, due to addition of pitch from the gas and to distillation, is converted to pitch, which at the high temperature of the main (350° F.) is liquid. By regulation of the amount of tar added and run off, a soft or hard pitch may be obtained free from ammonium chloride. Obviously tar fog carrying free carbon will pass from the collecting main to the condensing system, and so the whole pitch fraction will not be obtained. Undoubtedly, however, a distinct pitch fraction is produced. It will be noticed that the temperature in the Dessau main, i.e. 350° F., is much below the final temperatures obtaining in tar stills, and so the process is more one of evaporation than distillation. In my opinion Dr. Davidson's collecting-main method of producing the pitch fraction is superior to Feld's.

In the "Cava" process† for the distillation of tar the highest temperature to which the tar is subjected is from 200° to 250° C., according to whether a soft or a hard pitch is required. In this process the distillation, or, more correctly, evaporation of the tar is effected by passing heated air over the tar contained in a horizontal retort. Blades mounted on a revolving central shaft plunge into the tar and expose thin layers of it to the oxidizing and evaporating action of the brisk current of air. Some of the lighter products are oxidized, and so the amount of the bituminous substances in the pitch increases, and likewise the yield of pitch, and it is claimed that on account of the low working temperature there is no increase in free carbon. The evaporated products are condensed and treated in the usual way. Dr. Davidson's method involves at least the principle of the "Cava" process, but the separation of the tar products is limited to the pitch fraction, and this is not quite all recovered.

In order to carry out the complete direct fractionation of the tar within the condensing system, and also the evaporation and fractionation of a further quantity of crude tar by means of the sensible heat of the crude gas, I would suggest the following method, using the plant indicated diagrammatically in Fig. 1. Briefly the method is as follows. The crude gas from the collecting main passes by the upstand pipe, A, and the foul main, B, to the scrubber at C. Here the gas is scrubbed by a screen of anthracene oil containing some pitch, and all the tar fog containing the free carbon removed. The oil, etc., collecting in the receiver below flows to the pump, D, to be recirculated, and there is also a continuous flow of the oil into the collecting main. The amount passing into the collecting main would be just what is necessary to maintain the bulk in this main which would tend to decrease by the removal of pitch at E, and by evaporation. The gas passing C, after further partial cooling, is scrubbed in F for the removal of anthracene oil. The oil collecting in the receiver here is circulated by the pump, G, and all the surplus flows to the pot, H, and from there to the storage. The pot, H, being in communication with the inlet to the pump, D,

\* Transactions, Scottish Junior Gas Association (Western District), 1913-14.

† British Patent No. 29,897, 1912.

\* British Patent No. 20,189, 1907.

allows the anthracene oil to keep up the bulk in the first scrubbing system which would tend to be reduced by the flow into the main and also by evaporation. Several fractions, depending on the

main of a coke oven installation may reach  $300^{\circ}\text{C}$ . The temperature to which the gas must be reduced before reaching the first scrubber, is about  $150^{\circ}\text{C}$ . to  $170^{\circ}\text{C}$ . This reduction would be largely

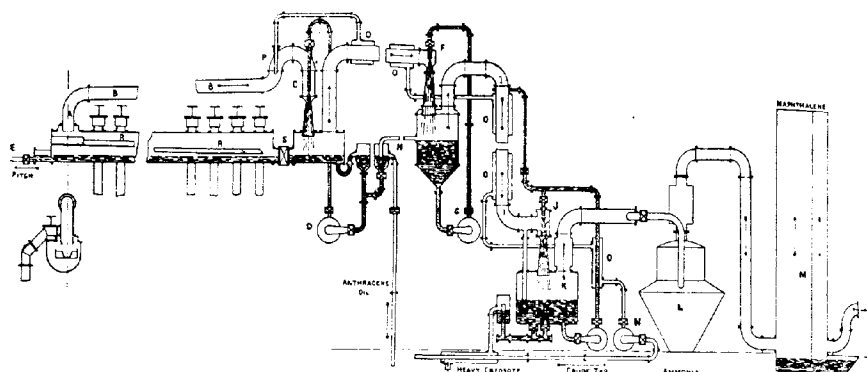


FIG. 1.

Combined Evaporation and Fractionation of Tar.

lowering of the temperature of the gas by successive stages, could still be separated, but the separation of only one more fraction above the water dew point of the gas will be considered. After passing F, the gas is cooled in the down pipe, I, to its water dew point and all the fog removed in the scrubber, J, by means of a spray of ammoniacal liquor. The tar oil collects in the receiver, K, separates from the liquor, and then flows to the storage. The liquor remains in the circulating system. The gas, completely freed from tar fog but still carrying all the water as vapour, is passed without further cooling through the direct recovery saturator, L, where the ammonia is removed. It is then quickly cooled in one section of M and naphthalene removed in the other. The naphthalene collects in the settling tank beneath as crude crystals. The gas now passes through the exhaustor and is forced through the usual creosote scrubbers for the recovery of benzol, etc.

As has been stated the crude gas is successively cooled between the different scrubbing systems. This is partly done by air cooling but also as far as possible by an externally applied counter current flow of crude tar brought in from other carbonising installations. This tar is forced by the pump, N, through the successive heat exchangers, O, into the foul main at its highest point, P. It would now flow down against the crude gas, cooling the same and being itself further heated. It would here yield up to the gas the bulk of its lighter constituents and finally reach the gas collecting main by the open tray, R. The work which has been done in the "Cava" process and by Dr. Davidson shows how simple and practical it is to produce pitch in such a vessel as the collecting main—it is sometimes too easy. In both of these methods the hot pitchy tar is kept mixed by mechanical agitators. This is not difficult in a short main such as is used with the "Dessau" retorts or in the "Cava" still which is only about six metres in length. But when dealing with say a 60-oven coking plant having a collecting main about 200 ft. long it is quite a different matter. To obtain the necessary agitation here several jets of high pressure steam blowing into the body of the liquid tar would be effective. Very little steam would be required, and after doing its work would pass away with the gas and be finally condensed. The gas leaving the collecting

effected by the crude tar entering the foul main at P and partly by external air. It would probably be advantageous to lag these mains and use all the sensible heat of the gas for heating and evaporating added tar. The oil from the first scrubber flowing in by the sluice valve, S, mixes with the highly heated tar in the collecting main. From the conditions of working, the tar in the collecting main would consist almost solely of pitch and anthracene oil, and in flowing to the outlet weir valve, E, would be evaporated by the heat of the crude gas till only pitch remained. By regulating the flow of pitch from E a soft or a hard pitch would be obtained. The crude gas, carrying as fog a portion of the pitch hydrocarbons and free carbon, would be cleaned in the first scrubber with oil at a temperature somewhat below the dew point temperature of the gas with regard to the lowest boiling compound of the pitch fraction. The gas temperature would vary with the conditions of carbonising, with the nature of the pitch required, and with the amount of added tar evaporated. Without added tar it would probably be about  $150^{\circ}\text{C}$ . With added tar, however, the dew point temperature would rise corresponding to the richness of the added tar in the lower boiling point members of the pitch fraction required. It is quite possible, therefore, that the proper working temperature at this point would vary by  $20^{\circ}$  or  $30^{\circ}\text{C}$ . between the conditions of working hard pitch with added tar and soft pitch without added tar. The lowest temperature at which this section could be worked would be that which would just maintain the oil level in the receiver. The type of scrubber proposed for cleaning the gas here is the "Otto" spray but using instead of crude tar the fraction here collected. A large proportion of the pitch fraction is deposited from the gas in the collecting main and the balance would be extracted in the first scrubber. This balance dissolves in the scrubbing oil and flows continuously into the collecting main. With these conditions the pitch fog is removed, not with the pitch fraction itself, but with a solution of a portion of the same dissolved in anthracene oil. This oil when sprayed through the gas in the scrubber would be partly evaporated and collected in the next scrubbing section. The temperature of the gas is lowered by this evaporation and more fog produced. But I have determined by experi-

ment that the bulk of this fog goes forward with the gas. The time during which the fog remains in the spray after its formation is too short for the drops to get big enough for extraction. The oil carrying the pitch into the collecting main is evaporated and comes down again in the condensing systems. There is thus a continuous circulation of anthracene oil carrying the balance of the pitch fraction back to the collecting main. An issuing pressure of 20 lb. per sq. inch would be sufficient in the first scrubber, this pressure being raised in a pump of the "Albany" or the "Drum" type.

The gas from the first scrubber is now cooled as explained above to the dew point temperature for the anthracene oil fraction and scrubbed with this oil. This oil flows through the pot, H, to the storage. Since the pot, H, is connected to the inlet of the first scrubber pump, the oil will naturally keep up the bulk in the first section. In this way the temperature of the scrubbing oil in the first scrubber will be lower than the temperature of the gas which it has to clean. As the temperature falls I have found the fog which is produced more and more difficult to extract. But I consider a spray pressure of 30 lb. per sq. inch would be sufficient in this section. The extraction temperature here would likewise vary with the carbonising conditions, but would be somewhat over 100° C.

The gas now enters the down pipe, I, at a temperature of at least a few degrees above the temperature at which ammonium chloride deposits occur, about 93° C. It is now cooled by the external counter current flow of tar as already described and also by ammoniacal liquor sprayed into it, which dissolves the ammonium chloride formed and so prevents deposits of that salt. This liquor returns to the receiver by the sealed dip pipe. In cooling the gas it will become itself heated above the working temperature and this is corrected in the heat exchanger. The gas, now cooled to its dew point with regard to water, is scrubbed in J by a jet of ammoniacal liquor at about 90 lb. per sq. inch pressure. This high pressure is necessary to extract the lightest fog. For the first two sections the "Otto" spray scrubber was suggested and the method of operation is similar to the usual practice, using, however, different scrubbing fluids. For this third section, however, in order to utilize the work done on the gas by the high-pressure jet, I think the best type of scrubber would be one designed on similar lines to the Körting ejector condenser. This would reduce considerably the work to be done by the exhaustor. In the receiver, K, the tar oil would separate from the scrubbing liquor and float on the top of it, finally passing away by the overflow to the storage as a heavy creosote oil. The liquor would remain in the circulating system. During the past year or two on the Auchengeich direct recovery plant I have made a number of experiments with the "Otto" spray tar extractor, and using creosote oil, liquor, and tar and liquor mixed at varying temperatures I have got efficient tar extraction. The most important point is to ensure that the fog which is to be extracted is present in the gas before it reaches the scrubber. The extraction temperature in this section would be from 70° to 80° C. according to carbonising conditions. From this point the gas is treated in normal direct recovery manner. For instance it is first freed from ammonia in the direct recovery saturator, L, and then naphthalene removed in, say, an "Otto" water spray naphthalene extractor, M. The gas is then forced by the exhaustors through the usual creosote scrubbers for the recovery of light oils. If the gas was required for town lighting, however, purifiers would take the place of the creosote scrubbers. In this particular case it is to be

remembered that the gas would be saturated with naphthalene vapour and any fall of temperature would cause a deposition. The content of naphthalene could be reduced by anthracene oil in the following way, somewhat on the lines of the Young and Aitken process and using the plant indicated diagrammatically in Fig. 2.

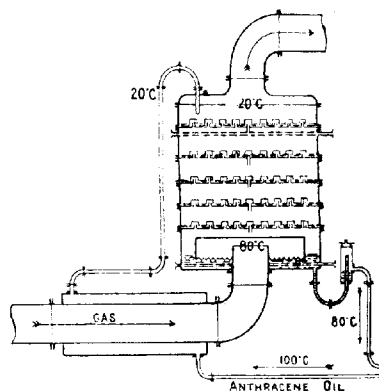


FIG. 2.  
Naphthalene Washer.

The cooled gas or a proportion of the total bulk after being heated to 80° C. passes into the bottom chamber of a washer similar in principle to the Young and Aitken analyser. Exhaust steam, or the sensible heat of the recovered tar fractions, or both could be used for this heating. This is not indicated in the diagram, but a heat exchanger is shown in which the washing oil is cooled from its recovery temperature to the temperature of the gas, the gas being itself partly heated. The cooled anthracene oil fills each of the trays up to the level of the overflow and runs through the washer in a continuous stream. In the bottom of the washer by means of a steam coil the oil is maintained at 80° C., at which temperature it leaves the washer. At 80° C. the anthracene oil cannot dissolve benzene and in fact, so far as examination of direct recovery tar extracted at this temperature indicates, very little solvent naphtha even is removed from the gas. This is no doubt due to the fact that the light oil vapours are far from saturating the warm gas. It is quite likely, therefore, that such a washer could be operated considerably below 80° C. without material effect on the benzene content in the gas; the lowest practical temperature could be found only by experiment. This oil outlet temperature being much below the boiling point of naphthalene, the anthracene oil will dissolve some of this hydrocarbon. The cold anthracene oil falling from tray to tray will be heated by the gas to 80° C. and the gas cooled. To ensure the gas being in contact with the oil at atmospheric temperature in the final tray, a cold water coil is placed in the gas space under the top tray. When the oil in the washer is saturated with benzene either by admixture or by extraction from the gas, no further action on the benzene in the gas can take place.

Referring again to Fig. 1, the plant from the third scrubber on is already applied in the direct ammonia recovery process, so that it is only that part between the collecting main and this third scrubber which is added to the ordinary direct ammonia recovery plant, for the fractionation of the tar. The cost of this addition, together with

the plant for dealing with the inbrought tar, for an installation carbonising 360 tons of coal per day would probably not exceed £3000 and would serve for the fractionation of all the tar produced and added. The inbrought tar which could be dealt with might possibly reach 75% of that produced from the coal carbonised. The main attendants already required on such a coking installation could quite well look after the two extra pumping sets, etc. The storage tanks required would be the same as those used in a tar distillery of the same capacity.

On account of the increased demand for benzene and toluene at the present time, there is added interest in the fractional method of recovering the tar products. In the ordinary condensing practice these products are divided between the tar and the cooled gas, so that to recover the whole of each, washing of the gas and also distillation of the tar must be resorted to. With direct fractionation only one operation, the washing of the gas, is required. Anything tending to increase the output of toluene, either by better recovery methods or by increased production per ton of coal carbonised, is highly desirable at the present time, not only on account of the better financial return but also on account of national requirement. The required conditions in carbonising would seem to be such as would give a high partial pressure of methane at the moment of destructive distillation. From experiments I have made on ammonia production in bulk carbonisation I consider the ratio of toluene to benzene produced will follow the yield of ammonia.

I have endeavoured above to show that in many of the special methods applied for the extraction of the tar, fractional separation has been an underlying factor. The condition "that the tar should leave contact with the gas only at such a temperature that it could not dissolve the light oils" which Mr. Young stated in 1876, is fulfilled in direct tar fractionation. Mr. Young abandoned the principle of the Young and Aitken process on account of the trouble with the condensers, etc., due to the greater amount of naphthalene produced in later carbonising practice but, as I have indicated above, an extended application of this principle using naphthalene-free anthracene oil would overcome this difficulty. I consider the method advocated by William Young so many years ago is still the correct one for gas works condensation practice and particularly so with carbonisation in continuous vertical retorts. In a number of works using these retorts, surprisingly low candle-power of the gas has been found on account of the light tar fog persisting with the gas till almost the final stages of cooling and so removing from it illuminating hydrocarbons.

#### DISCUSSION.

Mr. McLEOD said, in regard to counter current *versus* direct current flow in condensation, that it was really a temperature question. There was only a thin trickle of liquor and tar running down the slow condensing main, so that the actual contact was comparatively slight and there could be no very great scrubbing action: hence, provided the temperature did not fall—and in Greenock it did not fall below 140°—whether there were direct current flow or counter current flow did not make much difference. In Greenock Gas Works the naphthalene problem had been solved by putting down a separate washer with special washing oil, and in addition to that vaporising a little low boiling point oil into the gas after washing was finished. The system described by Mr. Purves was, however, a much simpler process.

Mr. VASS thought that there would be a saving of the fuel required to re-heat the tar. To apply

the system to gas works would involve a serious alteration in the mains.

Prof. THOMAS GRAY said that the method proposed by Mr. Purves for the fractional condensation of coal tar appeared to be quite practicable. It involved no new principle, as the method of separating liquids by bringing their vapours into equilibrium with condensates at different temperatures had long been practised in column stills; and the means which was proposed for establishing this equilibrium was one which had been in regular use for several years in connection with the Otto direct system of recovering by-products from coal distilled in coke ovens. He found it difficult to accept Mr. Purves' statement that the work in connection with the plant, involving as it did the regulation of temperatures in a somewhat elaborate system of heat interchangers, could be supervised by the same operative who takes charge of the simpler Otto plant. In order to ensure uniform results in practice it would be necessary to exercise very careful supervision and to employ more highly skilled labour. It would be interesting to have estimates of the costs of installation, upkeep, and working of a plant of the size proposed, for comparison with the corresponding figures for a plant designed to collect the tar in one fraction, combined with stills for the distillation of 15 tons of tar per day. While Mr. Purves was not in a position to give actual figures, he might be able to give some indication of the working costs from his experience in handling the "Otto" plant.

Mr. MOORE said that he had seen Feld's first plant in operation in Austria about six years ago, and which had failed, not because the process of condensation was a failure, but because in Austria they could not use the products and on account of duty charges they could not send them into Germany. Since then he had seen Feld's process successfully at work in Germany. It could produce pitch quite easily with a melting point varying from 70° C. to 90° C. A new plant on the Feld system in course of erection last year at Sterkrade was estimated to cost £60,000.

He considered the plant proposed by Mr. Purves would prove difficult to work as at present arranged, and saw no reason why a much simpler plant after the style of the bubble washer could not be used. That washer would require considerable pressure to force the vapour through the columns, but he thought the same result would be obtained.

Mr. W. H. COLEMAN asked whether the various condensates were obtained in a marketable condition. If they had to be distilled before they could be sold, then it was questionable whether it would not be more profitable to collect the whole in one fraction and distil at once rather than to collect and distil them all separately. He would like to know exactly what Mr. Purves meant by the statement that the yield of toluene followed the yield of ammonia. He thought he was right in saying that the yield of toluene decreased as the temperature increased, that is to say, when carbonising at a higher temperature the tar contained larger quantities of benzene than low temperature tar. He had examined some hundreds of samples recovered from coke ovens, and on the average there was three times as much toluene per ton of coal in the gas as there was in the tar recovered from that same ton of coal; so that if all the toluene were recovered from the gas there would be very nearly enough for the purposes for which it was required to-day.

Mr. ROBERTSON said that if the main were used for the purpose of making pitch, its life would be greatly reduced owing to the much higher temperature and the serious trouble that might arise, due to the presence of ammonium chloride in the tar; this substance when distilled acted strongly upon iron. With such a long main,

having regard to the danger of pitching-up, due to irregular working, and the fluctuating atmospheric temperatures, it would be difficult to keep the main at the requisite high temperature, and these difficulties would hinder very much the proper working of the coke ovens. By using steam to keep the pitch liquid, more water vapour would be carried away by the gas, and would be condensed out again on cooling the gas to remove the naphthalene, thus increasing the quantity of waste liquor to be dealt with. Mr. Purves had said that the benzol was divided equally between the tar and the gas: 95% existed in the gas, and the remaining 5% in the tar.

The CHAIRMAN said that the process proposed by Mr. Purves was rather a delicate one in respect of the balance that must be attained and maintained between the amount of heat carried into the condensing system and the cooling effects of that system. A difficulty that might upset all calculations was variation in atmospheric conditions. At any season of the year there might be a considerable variation in conditions within a few hours caused by a change from wet stormy weather to dry still weather. Moreover, he would expect a different rate of working necessary as between summer time and winter time. Manufacturers of pitch were asked to make it in various states of hardness. Some of it was wanted so soft as to be really thick tar, while, from the States, there was a demand for a quality so hard that it had lost all plastic qualities and become a very brittle substance. To produce such differences in hardness must call for great variation in the conditions of working, and he should be very doubtful whether these extreme varieties could be produced by the proposed process. He did not think the "Cava" process would be a good one for distilling tar, because the evaporation was done by means of heated air: some of the products were oxidised and a larger yield of pitch obtained. His own experience of blowing air through heated tar was that the free carbon was increased and the plastic and cohesive properties of the pitch were impaired, so he should not expect to obtain a good quality of pitch from the "Cava" process, but the principle might be usefully applied if hot gas could be used as in the hydraulic main. Mr. Purves proposed to wash out naphthalene with anthracene oil kept at a sufficient temperature to leave the benzol in the gas, but that seemed to him to depend on a rather narrow margin, and he thought it would be simpler to wash out everything and then put back sufficient benzol to give the illuminating power required. By working in that way it was possible that purification of the gas would be assisted. For instance, by washing with blast furnace oil, which was a splendid solvent for naphthalene, benzol, and carbon bisulphide, it might be possible to remove practically the whole of these substances.

Mr. PURVES, in reply, agreed with Mr. McLeod that it mattered little whether the slow condensing main was on the direct current or the counter current principle. The effect on the gas of the small quantity of condensed tar in the main was trivial compared with that of the tar fog. In regard to the suggestion made for dealing with the naphthalene problem, his intention was to show that an extended application of Young's counter current condensing practice would overcome the principle difficulty which had caused him to abandon his process. In addition to the saving in fuel which successful direct fractionation would effect, the fractionation of added tar from other carbonising plants would yield a further fuel economy. Prof. Lewes had quoted ("Carbonisation of Coal") 9.2% as the proportion of the heat applied in carbonisation, which was carried away by the gas, tar, and water. In coke oven practice

with wet coal the proportion was probably somewhat higher. As Dr. Gray had stated, the method proposed for the fractional collection of the tar involved no new principle. It was all covered by the work of William Young. The application of fractional tar collection in modern practice was, however, almost wholly the work of foreign chemists, as witness the Feld process and the direct and semi-direct ammonia recovery processes. It appeared well worth while to have a discussion on the subject by our own chemists. He selected the "Otto" tar spray for the removal of the tar fog because after practical experience with several types of tar fog extractors he considered it easily the best. The regulation of the temperature of the gas to the water dew point, as was required in the Otto process, was quite simple and was done by the man in charge of the exhausters. The controlling of the other two temperatures could quite well be done by the "main" attendants, as their ordinary duties would be done away with in such a process as this.

As Mr. Moore had remarked, the benzene and toluene were not fractionally condensed. He would draw a very distinct line between condensation of tar and absorption by tar. These two products, benzene and toluene, were not, properly speaking, condensation products. Since the permanent gas was quite able to carry the whole of each by saturation at ordinary temperature, the presence of these in the crude tar was entirely due to solution, the gas and tar having cooled sufficiently in contact with each other. He did not share Mr. Moore's opinion of the equal suitability of bubble washers. With a large bubble washer it would be more difficult to maintain constant temperature with a simple tar spray.

The fractions obtained in direct fractionation would differ somewhat from those obtained in the ordinary tar distillation and partial destructive distillation process. Comparing the products solely within the scope of direct fractionation, he would hardly expect a difference of a few degrees in the extraction temperature to make a material difference in the composition of the product. He had not actually obtained all these condensates. The process was really only a suggested one. But judging from those fractions which had been obtained and from the efficiency of the tar extractor, he was confident that the fractional separation of the products would be quite clean; for instance, the anthracene oil would not be contaminated with the tarry matter of the previous fraction. The heavy tars were more easily separated than the lighter ones. After scrubbing the hot crude gas with a hot tar spray he had seen the sulphate produced, by the direct method, snow white and later the naphthalene extracted bright yellow in colour. The melting point range of the latter was found to be 69–72°C. as against 70–73°C. for that separated from creosote in a tar distillery. He agreed that the future of such a process would depend on the cleanness of the fractionation. In regard to the yield of toluene, he did not mean that those conditions which would give the highest possible yield of ammonia would also give the highest possible yield of toluene. In order to get the highest commercial return from a carbonising plant it was necessary to work within a certain range of temperature and other conditions. Within that range the yield of ammonia varied in the same direction as the yield of methane. As a high partial pressure of methane at the time of carbonising would seem to be the required condition for good yields of toluene, he would expect the ratio of toluene to benzene produced to vary in the same direction as that of the ammonia and the methane. The ratio Mr. Coleman gave for toluene in the gas to that in the tar was, he thought, much too low. The ratio,

however, might be anything, as it was purely a function of the method of condensation.

The temperature in the main would not be higher than that already found in mains without dip pipes and working with all tar conditions. In regard to possible corrosion from ammonium chloride, he thought too much was generally made of this factor and he could not agree that any corrosion at all would occur. At the high temperature occurring here ammonium chloride would not exist at all as such, and its free radicals would not combine until the temperature fell to somewhat under 100° C. The free hydrochloric acid could not corrode the iron, as the crude gas was dry until the temperature fell and the water dew point was between 60° C. and 75° C. Once formed and dissolved the chloride was always present in excess of ammonia, and as there was no question of dissociation, there was no evidence of internal chloride corrosion in the plant after fully four years' continuous working. There would be no greater danger of pitching up than there was with other collecting mains working under all tar conditions, and the problem was not to keep the main at the requisite high temperature, but rather to bring the temperature down. The use of steam in the collecting main would certainly increase the amount of condensate ultimately produced, but this condensate was not a noxious product such as was produced from ammonia stills. He did not say that the benzol was equally divided between gas and tar and thought the proportion stated by Mr. Robertson was about correct. With direct recovery practice, however, no benzol, etc., occurred in the tar. He understood that if proper care were taken in the working of the Cava process no increase of free carbon occurred. The washing of the gas to free it partly from naphthalene as carried out in gas works was done solely to reduce the tendency to choking in the distribution system, and simple washing was cheaper than combined washing and distillation of the absorbing oil.

*Meeting held at Glasgow on Tuesday, 23rd February, 1915.*

MR. ROBERT HAMILTON IN THE CHAIR.

#### MOLASSES AS A SOURCE OF ALCOHOL FOR THE PRODUCTION OF POWER.

BY T. H. P. HERIOT.

The suitability of alcohol for generating power in the internal combustion engine has been sufficiently established by exact tests and by practical experience of alcohol motors for general purposes. The conclusion thus drawn is that, although the calorific value of alcohol is little more than half that of petrol, the efficiency per b.h.p. is from 28% to 31% compared with from 16% to 20% for petrol. This higher efficiency of alcohol is due to several factors, namely:—The volume of air required for complete combustion is about one-third of that required by petrol, thus reducing the waste of heat in the exhaust. This smaller dilution with air ensures more perfect admixture before the explosion, and, consequently, favours complete combustion. The mixture can be subjected to a pressure of 200 lb. per sq. inch in the cylinder without spontaneous ignition; the safety limit for petrol is 80 lb. Mixtures of alcohol vapour and air, containing from 4 to 13.6% alcohol, are all explosive, whereas the explosive range of petrol is from 2 to 5%, thus requiring more exact adjustment of petrol and air in the cylinder. The exhaust from the alcohol engine is smokeless and nearly odourless, and the products of combustion do not clog the cylinder valves.

In view of the rapid development of the internal combustion engine, and the increasing cost of petrol,

which may be expected to rise considerably as the limited supplies become partially exhausted, it is reasonable to regard alcohol as the fuel of the future, and to inquire whether it might not compete successfully with petrol to-day if produced from the cheapest raw material, and freed from existing taxes which artificially increase its cost far beyond the actual cost of production.

The raw materials now available are starch, cellulose, and sugar. In the case of starch, the cost of alcohol includes that of raising the crop, harvesting, and transport to the distillery before the conversion of starch into alcohol commences. In the production of alcohol from sugar, however, the by-product of an existing industry is available, namely, molasses. The cost of raising, harvesting, and transporting the cane or beet crop is rightly charged to the sugar. This comparison between starch and molasses is well illustrated by Peck, of Hawaii. "If the 21 million gallons of molasses produced in these islands in 1913 had all been converted into alcohol, over 9 million gallons of 90% alcohol would have been produced. A bushel of corn yields 2.8 gallons of 90% alcohol, and an average yield of corn is 30 bushels per acre. Therefore, to produce 9 million gallons of alcohol, 3,248,000 bushels of corn would be required, representing a crop from 108,000 acres, an area only 5000 acres less than that from which the 21 million gallons of molasses were derived together with the main crop of 500,000 tons of sugar shipped." Similarly, a bushel of potatoes yields 0.73 gallon alcohol and an average crop gives 205 bushels per acre. Thus, 9 million gallons of alcohol would require a crop from 60,000 acres, or 53% of the acreage required in Hawaii to produce the same quantity of alcohol plus 50,000 tons of sugar.

Another point in favour of molasses is that it has only to be diluted in order that fermentation may commence. In tropical distilleries adjoining the sugar factories, the air-borne yeast is sufficient to cause vigorous fermentation within a few hours after dilution or, as it is called, "setting up the wash."

The manufacture of alcohol from molasses is a long established industry, and in many countries a distillery forms an adjunct to the sugar factory and is worked under the same management. Hitherto, the manufacture of rum has been the object in view, although methylated spirit is produced in some countries. But, owing to the small demand for rum and the cost of freight and containing vessels, other methods of utilising molasses have been adopted and are referred to below. In some countries, molasses is literally a waste product, and the problem is how to get rid of it. The erection of large distilleries in sugar growing centres might solve this problem if there were a steady market for alcohol as fuel and cheaper means of transport than those now employed.

#### Cane molasses.

The possible production of alcohol from this source may be calculated from the statistics and analyses given in Tables I., II., and III.

TABLE I.  
The world's production of sugar.

	1909-10.	1910-11.	1911-12.	1912-13.	1913-14.
	tons.	tons.	tons.	tons.	tons.
Cane	8,349,000	8,354,000	9,087,000	9,177,000	9,905,000
Beet	6,587,000	8,590,000	6,820,000	8,909,000	9,128,000
Total	14,936,000	16,944,000	15,887,000	18,143,000	19,033,000

Average for cane = 9 million tons. Average for beet = 8 million tons.

Table I. shows the production of cane and beet sugars for the years 1909 to 1913. The average annual production for these years was very nearly 17 million tons, 53% of which was cane sugar.

TABLE II.  
*Production of cane molasses.*

	Million gallons.	Per cent. on sugar made.
Hawaii .....	16	19.5
Java .....	52	25.4
Cuba .....	90	27.3
Queensland .....	6½	24.4
Egypt .....	1½	22.0
Average .....	—	23.7

Table II. gives the production of cane molasses in a few typical countries, also the percentage by weight of molasses on commercial sugar produced. This percentage varies with the purity of the raw juice, which, in turn, is influenced by climate, soil, and variety of cane cultivated. Excluding one higher percentages due to antiquated processes or inferior machinery, the above figures average 23.7% of molasses on weight of sugar. The world's production of 9 million tons of cane sugar includes 2½ million tons of Indian "gur" from which no molasses is separated, but which represents the total solid matter of the juice after vaporation of the water. This native sugar is partly consumed as such, or partly refined by the consumer. Only a few modern factories and refineries exist where this crude product is worked up into white sugar yielding molasses. Of the molasses thus produced, about 5% is converted into alcohol, another 10% is consumed in the raw state, and the remainder is used for mixing with tobacco.

As there is little prospect of modernising the sugar industry of India, her contribution of molasses is too uncertain to reckon upon in calculating the possible production of alcohol. Deducting India's contribution of sugar, there remains 0½ million tons of cane sugar yielding 23.7% by weight of molasses, or 1½ million tons of cane molasses.

The composition of molasses varies with the purity of the juice extracted from the cane; the following limits for each constituent are given by Deerr in his treatise on "Cane Sugar": water, 5 to 25%; sucrose, 25 to 40%; reducing sugars, to 30%; ash, 7 to 15%; gums, 3 to 5%; other organic non-sugars, 10 to 20%. The value of molasses to the distiller depends solely on the contained sugars, and these percentages are given in Table III.

TABLE III.  
*Composition of cane molasses.*

	Sucrose.	Reducing sugar.	Total as glucose (dextrose).
	%	%	%
Hawaii (25 factories) ..	36.0	14.0	52.0
Java (70 factories) ..	33.2	23.6	58.5
Cuba (1914 crop) ..	33.4	18.1	53.3
Queensland .....	27.0	23.0	57.4
Egypt .....	30.2	16.8	58.0
Average .....	35.0	30.0	67.0
Average .....	—	—	57.7

Sucrose, although not directly fermentable, is rapidly inverted by the invertase of yeast with formation of fermentable sugars. Column 3 of the

Table gives the total sugars expressed as glucose, and the average is 57.7%. On 1½ million tons of cane molasses, this represents 865,500 tons of glucose (dextrose).

Theoretically, glucose yields 51.1% by weight of alcohol. The lower yields obtained in modern distilleries are due to the following causes: Incomplete fermentation of the sugar present owing to lack of nutrition of the yeast cells; bacterial infection causing decomposition of sugar without formation of alcohol, or producing toxic acid substances which retard or prevent the development of the yeast; insufficient aeration during fermentation; the presence of unfermentable reducing substances in molasses which are reckoned as fermentable sugar by the usual methods of analysis; losses of alcohol during distillation.

The investigations of Deerr and Peck proved that 83% of the total sugars present in molasses can be converted into alcohol. From 5 to 6% is consumed in the formation of glycerol and other by-products of fermentation, and about 6% apparent loss is due to unfermentable substances reckoned as sugar.

The possible production of alcohol from cane molasses is, therefore, 83% of 865,500 tons = 718,365 tons glucose, yielding 51.1% alcohol, or 367,000 tons.

#### *Beet molasses.*

The average yield of commercial sugar % on roots was 15.38 in ten European countries during the 5 years ending 1911. The highest yield was 16.32% in Germany, and the lowest 13.18% in France. The yield of molasses varies from 3 to 4% on the weight of roots. Taking the lower figure, there would be obtained 19.5 tons of molasses per 100 tons of commercial beet sugar. This ratio has been much reduced by various methods of extracting the uncrystallisable sugar from molasses; thus, a modern German factory extracted 16.6% commercial sugar and obtained only 1.33% of molasses, or 8% molasses on weight of sugar. But, when molasses is to be converted into alcohol, such further treatment is not profitable and the above ratio of 19.5 may therefore be adopted.

Beet molasses contains from 18 to 53% sucrose, 10 to 12% ash, 18 to 20% organic non-sugars, and about 20% water. As this forms a very viscid material, it is usually diluted somewhat before leaving the factory. The theoretical yield of alcohol is 53.8% of the contained sucrose, and the practical yield may be put down at 83% of this, as in the case of cane molasses.

The possible production of alcohol from beet molasses is, therefore, as follows: 8 million tons of beet sugar yielding 19.5% or 1.56 million tons of molasses, containing 50% or 780,000 tons of sucrose: 83% of this is 647,000 tons yielding 53.8%, or 348,000 tons absolute alcohol. Total possible production from cane and beet molasses = 715,000 tons, or 200 million gallons.

This estimate is considerably lower than that which appeared in the "Fuel Supplement" to "The Times" of December 1st, 1913, from which the following extract is taken. "On the assumption that 18 million tons of sugar are produced annually, half being cane and half beet, and that for every 100 tons of cane sugar, 30 tons of molasses containing 50% sugars are produced, this represents 2½ million tons of cane molasses available for fermentation. Assuming 90% of the theoretical yield of alcohol to be obtained in practice, this would yield 650,000 tons of absolute alcohol. In the case of beet, it is assumed that for every 100 tons of beet sugar, 17.4 tons of molasses, containing 50% sucrose, are produced. This represents 1,566,000 tons of beet molasses capable of yielding 350,000 tons of absolute alcohol. Total from cane and beet molasses is one million tons."



The production of cane molasses appears to be over-estimated by assuming that the sugar produced in India yields the normal proportion of molasses. Further, the assumption of 90% of the theoretical yield of alcohol appears excessive.

*Actual production of alcohol from molasses.*

In the article just referred to, it is further estimated that the equivalent of 52,000 tons of absolute alcohol is annually produced in the form of rum from cane molasses. Deerr estimates this production at not less than 20 million gallons of spirit, containing 75% alcohol. This corresponds closely with the above estimate. The actual production of alcohol from cane molasses is, therefore, 14% of the possible production, based on the data given above.

Statistics relating to the production of alcohol from molasses alone are scanty, but the following few examples are of interest. In 1905, the United States of America produced rum equivalent to 896,000 gallons of absolute alcohol, and other spirits equivalent to 6 million gallons of absolute alcohol from molasses, probably both cane and beet. The total production from grain, molasses, and other materials was 74 million gallons, so that the molasses-alcohol represented 9.3% of the total. In 1902, Peru produced 2 million gallons of alcohol from cane molasses only, and exported 600,000 gallons. In Mexico, the annual production from cane molasses is about 22 million gallons. In 1904, France produced 13.8 million gallons from beet molasses out of a total production of 49.6 million gallons, or 27.8% from molasses. In the same year Germany produced 2.45 million gallons of 95% alcohol from beet molasses out of a total production of 101.8 million gallons, or 2.4% from beet molasses.

*Molasses compared with other raw materials.*

The practical yield of alcohol from different raw materials, and the approximate cost of each per gallon of 90% alcohol produced from it, is shown in Table IV.

TABLE IV.  
*Practical yield of alcohol from different raw materials.*

	Gallons absolute alcohol produced per ton.	Percentage of theoretical yield.	Cost of raw material per gallon 90% alcohol.
Cane molasses (57.7% total sugars) .....	69	83	Nil to 8d.
Beet molasses (50% sucrose) .....	63	83	Nil to 8d.
Potato (20% starch) ..	30	77	7½d.
Beetroot (15.4% sucrose) .....	20	87	1/1
Maize (50% starch and sugar) + 8% malt ..	84	87	11½d.
Rice (75% starch) ..	80 to 90		
Wood sawdust .....	28 to 45		
Nipa-palm sap (14- 16% sucrose) .....	5-6% by vol.	74	6d.

The yield from molasses of the above composition and of 1.47 density may also be expressed by volume, as follows:—

- 1 gallon of absolute alcohol is obtained from 2.2 gallons cane molasses, or 2.5 gallons of beet molasses;
- 1 gallon of 90% alcohol is obtained from 2 gallons cane molasses, or 2.3 gallons of beet molasses.

The value of molasses varies from nil, when it is thrown away, up to a maximum of about 4d. per gallon, so that at this highest value, the cost of molasses per gallon of alcohol obtained would be 8d.

Beet molasses has about the same value as cane molasses per gallon of alcohol obtained therefrom. The variable value of cane molasses may be illustrated in the case of Cuba. Prinsen-Geerlings states that by far the greater part of Cuban molasses is sold to the Whisky Trust of the United States, but some is sent to Europe, some is distilled locally, and the remainder thrown away as useless. When sold, the price varies from 3 to 8 cents per gallon, according to its percentage of sugar. The market price of molasses further depends on its value for other purposes than the production of alcohol, which may be briefly mentioned. When used for feeding stock on the sugar estate, the contained sugars are converted into work and the fertilising constituents, namely, potash and nitrogen, can be returned to the fields in the form of dung, thus utilising the molasses to the fullest extent with a minimum of labour. Or, the molasses may be sold for the same purpose, either in the raw state or mixed with other materials, as in the well-known cattle foods sold under the names of "Molascuit" and "Molassine." The former is a mixture of molasses and finely divided cane-fibre; in the latter, dried moss is substituted for cane fibre. Both products can be manufactured on the sugar estate or in the locality, and the meal thus produced can be shipped in sacks.

Molasses is also frequently used as fuel when the supply of crushed cane from the mill is insufficient to supply steam to the sugar factory. The carbohydrates are thus utilised, but the fertilising constituents in the residual ashes are either lost or rendered unavailable to the plant by fusion in the furnace.

As a fertiliser, molasses is very troublesome to handle and the carbohydrates are lost by fermentation in the soil, which tends to produce acidity and sourness when the soil is deficient in lime.

There remains the possibility of first converting the sugars into alcohol and then utilising the residual liquid as fertiliser, or extracting the potash and nitrogen from it.

Peck states that the loss of potash in molasses exported from Hawaii or run into the sea amounts to one-third of the total potash annually imported to the United States from Germany. That supply being now cut off, the recovery of potash from molasses becomes more urgent. A long ton of Hawaiian molasses contains 89 lb. potash, 14 lb. nitrogen, and 4 lb. phosphoric acid. These constituents were formerly valued locally at 6, 20, and 2 cents per pound respectively, giving a total value of \$8 per long ton of molasses, whereas the market value was \$6.6. The value of potash salts has since increased five-fold. On burning, molasses yields a charred residue containing about 20% potash, but the nitrogen is lost. If the molasses be first fermented and distilled, and the residue evaporated and burnt, this evaporation increases the cost of recovering the potash. In countries where the sugar cane is irrigated, the dilute distillery residue can be discharged into the irrigation canals and thus distributed over the fields without labour or expense. But, in other cases, the liquid must be concentrated as far as possible to facilitate transport. Complete evaporation of the water is difficult, and, as the solid matters are hygroscopic, a marketable article is not easily obtained. A method of treating the residue from distilleries working with beet molasses is to mix the highly concentrated liquid with superphosphate, which absorbs it, forming a fairly dry product.

*Cost of producing alcohol.*

If the potash and nitrogen are recovered after fermentation and production of alcohol, their fertilising value covers all expenses of distillation, leaving alcohol as a by-product, free of cost. Assuming, as we may, that the future production

of alcohol from molasses would be on a larger scale than in the distilleries now producing rum, this complete utilisation of molasses would be more practicable than at the present day. The profits which might be expected are indicated by the following balance-sheet, which is reproduced from a paper on "The cost of manufacturing alcohol from molasses," by Antoni, of Hawaii.

#### *Distillery Balance Sheet.*

Daily expenses, treating 2000 gallons of molasses—	
Oil for distilling 870 galls. alcohol = 435 galls.	
" evaporating 8000 galls. water = 200 "	
	635 galls. at 4 cents = \$25.40
4 men at \$1.50 .....	6.00
Distiller at \$10 .....	10.00
	41.40
For crop lasting 175 days, treating 350,000 gallons of molasses .....	
Depreciation and repair = 10% .....	\$7,215
Interest and taxes = 10% .....	2,000
Incidental expenses .....	755
	10,000
Denaturing agent, 15,000 galls. at 20 cents .....	3,000
Total expenses .....	\$13,000
Returns—165,000 galls. denatured alcohol of which is used for:—	
Ploughing the estate 25,000 galls. at 10 cents...	\$2,500
Hauling cane to factory 50,000 galls. at 7-5 cents.	3,750
Sold outside .. 90,000 galls. at 15 cents.	13,500
	\$19,750
175,000 galls. fertiliser syrup at 9 cents. ....	15,750
	35,500
Total .....	13,000
Expenses .....	
Profit .....	\$22,500

Taking as an example a sugar plantation of 5000 acres, producing 12,500 tons of sugar and 350,000 gallons of molasses during a crop season of 175 days, the distillery has to treat 2000 gallons of molasses per day, or 10,000 gallons of diluted molasses after fermentation.

The chief item of expense is fuel; but a modern sugar factory can usually supply sufficient steam for distillation as well as for sugar manufacture from the crushed cane leaving the mills, a fuel which costs nothing.

But it is here assumed that oil fuel is used both for distillation and for the subsequent concentration of the distillery refuse to the form of syrup which can be used as fertiliser on the estate. For distillation, not more than half a gallon of oil is required to produce 1 gallon of strong alcohol, while for evaporation by multiple effect, 200 gallons of oil is required to evaporate 8000 gallons of water from the distillery residue, leaving 1000 gallons of fertilising syrup.

The total working expenses for the crop are \$13,000, while the fertilising syrup is valued at \$15,750, showing a profit of \$2,750 on this item alone. Of the denatured alcohol produced, a portion is used for producing power for ploughing and for hauling canes to the factory, the remainder being sold at 15 cents per gallon. Alcohol motors of 35 H.P. are sold in Honolulu for \$4500 and require 13-5 oz. alcohol per H.P.-hour. A 40 H.P. locomotive, burning oil fuel, consumes 30 oz. oil per H.P.-hour. Thus, 1 gallon of alcohol in the motor does as much work as 2 gallons of oil in the locomotive, making alcohol worth twice as much as oil, or 7-5 cents per gallon. On this basis, 50,000 gallons of alcohol would be required to haul 100,000 tons of canes to the factory. Motor-driven ploughs consume 5 gallons of petrol per acre, and, if the whole estate be ploughed once a year, this will consume 25,000 gallons of petrol. Alcohol substituted for petrol is worth 10 cents per gallon.

If the factory had sold its molasses at the average market price of \$8 per ton, it would have received

\$12,000. The apparent value of the molasses is therefore \$11.25 per ton, or 6-4 cents per gallon.

Another Hawaiian authority, Peck, shows how the profits of the distillery vary according to the following conditions.

Case 1. The sugar factory has sufficient fuel or crushed cane to supply steam for distillation and for recovery of potash and nitrogen from the residue. The profit per ton of molasses will then be \$15.7, and the molasses is worth 9-4 cents per gallon.

Case 2. The sugar factory has no surplus steam, so that distillation is done by oil fuel, and the distillery residue is discharged into the irrigation canals without further treatment. This shows a profit of \$15 per ton of molasses, or 9 cents per gallon.

Case 3. Oil fuel must be used for distillation and also for concentration of the residue. This shows a profit of \$13 per ton of molasses, or 8 cents per gallon.

In all three cases, the whole of the alcohol is sold at 25 cents per gallon, and consequently shows a higher profit than in the estimate previously quoted. But, viewed from another standpoint, the alcohol could be sold at the distillery at 9, 10, and 13 cents per gallon under the conditions 1, 2, and 3 respectively, in order to realise the normal value of \$8 per ton of molasses treated.

Such estimates must necessarily be based on local market values and conditions, but are of sufficient general interest to be mentioned. Most of the distilleries attached to cane sugar factories are only equipped for producing alcohol, and are generally on too small a scale to permit of the economic recovery of potash and nitrogen from the residue. This is therefore discharged into the nearest stream.

The cost of producing rum in Demerara may serve as an illustration, and the process of manufacture may first be briefly described. The molasses is diluted with water to a density of 1-06, the "wash" is acidified by the addition of 1 gallon sulphuric acid per 1000 gallons, in order to prevent bacterial growth which may interfere with the alcoholic fermentation. Nitrogenous food for the yeast is also added in the form of 10 lb. of ammonium sulphate per 1000 gallons, in order to accelerate the fermentation, which is complete in from 2 to 3 days. The density then falls to about 1-010, and this fall or attenuation is a measure of the alcohol produced. Multiplying the initial and final densities by 1000, every 5 degrees of attenuation indicate the formation of 1-06 gallons of proof spirit per 100 gallons of wash. For distillation, continuous stills are largely used, but vat or "pot" stills produce a more palatable rum owing to less perfect rectification. The working expenses are very small. Two men are required for setting up the wash in the fermenting vats, and two boys are sufficient to operate the still. No expert distiller is necessary, but the work is under the supervision of the chemist in the sugar factory, who records the quantity of sugars in the molasses used, and thus has a control on the yield of alcohol obtained. The alcohol from the still is coloured by the addition of caramel, prepared on the spot by burning molasses or low-grade sugar, and then has an apparent strength of 40 overproof. The heaviest expenses are incurred after the alcohol has been produced, namely, for puncheons to contain it, and for freight abroad.

Actual figures for a Demerara distillery show that the total cost of rum, landed in England, is \$24 per 100 gallons, or 1s. per gallon. Of this total, the cost of puncheons, freight, and commission amounts to \$19, while the working expenses, including labour, coal, and acid, amount to only \$5 per 100 gallons, or 2½d. per gallon of rum, equal to nearly 3d. per gallon of 90% alcohol.

According to different authorities, the cost of manufacturing 95% alcohol, without recovering potash and nitrogen, and excluding the cost of molasses itself, is stated as follows:—8 cents per gallon in the U.S.A., 5 cents in Demerara (exclusive of fuel), 10.2 cents in Hawaii, and 10 cents in Cuba. The actual working expenses therefore approximate to 5d. per gallon.

Transport by tank steamers would materially reduce the cost of alcohol imported from abroad, and tank transport from the distillery to the port of shipment would not present any great difficulty.

The transport of molasses for subsequent conversion into alcohol, does not seem to offer a more satisfactory solution of the problem, but, with this object in view, a process for producing solidified molasses for transport has been suggested by Prinsen-Geerligs.

There is little doubt that alcohol could be substituted for petrol and coal in most sugar producing countries, and Germany has shown what can be done in fostering the production of potato spirit. In 1903 potato spirit was there retailed at 7d. per gallon, and motors specially designed for alcohol fuel were put on the market. Brachvogel mentions that one firm in Berlin had contracts for supplying over a thousand of these motors which were to be used for the following purposes: Agricultural operations, 544; pumping plants, 88; creameries, 63; electric light plants, 52; woodworking machinery, 45; flour mills, 40; bakeries, 33; motor trucks, 30; boats, 30. The rest were required for general power purposes.

In 1904, the retail price rose to 1s. 3d. per gallon, owing to the failure of the potato crop, so that petrol then became the cheaper fuel in spite of the import tax.

As regards this country, the production of alcohol from beet molasses should contribute towards the success of our struggling beet sugar industry. Or, the beetroot might be cultivated solely for producing alcohol, as has been done so successfully in France.

*Meeting held at Edinburgh on Tuesday, December 8th, 1914.*

PROF. G. G. HENDERSON IN THE CHAIR.

#### DISCUSSION ON THE BEARING OF THE PRESENT WAR CRISIS ON THE CHEMICAL INDUSTRIES OF THE EAST OF SCOTLAND.

Professor HENDERSON said that the reasons for the German supremacy in the chemical industry were pretty obvious. As business men they had shown themselves remarkably acute, remarkably enterprising, and thoroughly unscrupulous; but, putting aside the business aspect altogether, on the purely scientific side they had shown the utmost enterprise in following closely the results of all scientific work, and in attracting to themselves the best possible scientific advice. They had shown great courage in spending enormous sums of money in acquiring knowledge by means of experiment, and there was no gainsaying that the great success which they had attained had been thoroughly well deserved. Endeavouring to explain the backwardness of our manufacturers in this matter, he said that one undoubted reason was the general attitude of indifference, even of opposition, which this country showed towards scientific work—an attitude, however, which he was glad to think was gradually changing. Then, again, there was no question but that manufacturers in this country were under a decided handicap from the point of view of fiscal matters. He emphasised the great need of systematic experimental work, and said

that if our manufacturers had not been so successful as their rivals it was because they had not to the same extent made use of the scientific resources in the shape of men and material which lay to their hands. He thought there was a great opportunity, not only to capture trade, but, what was more important, to retain it, and he was perfectly certain that if our manufacturers would only allow their powers of initiative, courage, and enterprise full scope they would see their industry develop rapidly, successfully, and profitably.

Principal A. P. LATHIE said that during last autumn the Board of Trade had appointed a Committee representative of manufacturers and men of science, with Lord Haldane as chairman. That Committee had separated into sub-committees to deal with different branches of the chemical trade, and Lord Moulton had undertaken the chairmanship of all the sub-committees. An immense amount of information had already been collected. One curious point that struck the members of the Committee was how seldom the manufacturers and the consumers were in touch. A manufacturer might send his samples to the broker, but did not get any business; but he did not know why he was not getting the business, and in many cases he was quite ignorant of the reason and therefore had never tried to improve his methods. One of the results of the inquiry had been to bring together the manufacturer and consumer, to their mutual advantage. The principal department he (the speaker) had looked into was that of the manufacture of paints and colours. There were very few cases among those he had inquired into of a chemical, a colour product, or a pigment, which was being made both in Germany and in England, in which the German product was not better than that made in this country. In many cases the English manufacturer was not aware of this until he had compared his own sample with the German product. Many English manufacturers had been content to have the second-class trade. There was also the question of improper packing; for instance, a manufacturer of a crystalline product does not dry the crystals, and then drives iron nails into them, with the consequence that the consignment is full of rust.

The Committee had also inquired into the question of the shortage of supplies; for example it had been found that there was a shortage of ultramarine and lithopone; manufacturers had then been approached, and had arranged to increase their output to meet the shortage. In other words, the inquiry had already done a great deal to meet the practical needs of the situation. He thought that in the past the manufacturer had been too narrow in his outlook; he had guarded jealously his little trade secrets, and had been afraid to ask for information for fear of giving something away, and thus had not developed his business as he ought to have done. Again, there were a great many barytes mines in England and Ireland. These mines were visited and their working conditions examined. There were in this country very large mineral resources which had never been submitted to proper scientific examination. There should be a proper survey of these districts where all old mines and existing mines were examined and a careful study of the deposits made. The mining valleys ought to be opened up by light railways. The big railways hesitated to do that because they had not the facts before them. Another and still bigger question was that of railway rates. For example, it was possible to carry barytes from Germany to the docks in London for 6s. a ton. As long as that condition of things existed we were at a great disadvantage. Again, it was admitted that German barytes was better ground than English. Yet an extensive literature on barytes and barytes mining had been published by Germans, showing exactly how German barytes

was ground. They had not found a barytes miner in England who owned a microscope. The Committee had collected numerous samples of barytes at different stages of grinding, and submitted them to rigid microscopical examination. From that they had been able to give manufacturers definite information by which they could improve their product. The English manufacturer did not believe in or use the man of science. The Germans had used the man of science in the proper way in the chemical industry. In this country it had not been done or only to a very limited extent.

There was a great opportunity during the war to improve existing products while German competition had ceased, to scrap old plant and fit out our heavy chemical works with modern plant, and to start the manufacture of new articles never manufactured in this country before, and which Germany had been making. With pluck and enterprise those changes could be carried out.

Mr. D. B. DOTT, speaking of the effect of the war on medicinal chemicals, said that stoppage of raw materials, limitation of markets, and Government interference, had so far resulted in less disturbance of trade than was anticipated. Taking chloroform, ether, caffeine, morphine, salicin, and strychnine as the principal products of the Scottish factories, the mean rise in price had not been great. The materials needed for making these products were not in any case obtained from Germany, although they had formerly supplied a good deal of the acetone used in preparing chloroform. The willow bark for salicin had come mainly from Belgium, but salicin was not indispensable. The rise in price of the rarer alkaloids or those which were used in smaller quantity had been quite marked. That was due to the fact that, with few exceptions, such alkaloids as atropine, cocaine, pilocarpine, and veratrine, had been mostly imported from Germany. There was no reason why they should not all be made in this country. In the case of atropine, however, the requisite belladonna was chiefly grown in Austria and Germany. Supplies of opium from Asia Minor had been interrupted, but supplies were obtainable from Persia. It would be a great advantage if India were available as a source of opium for preparing morphine. Most of the opium produced in that country was unsuitable for that purpose, and the area under poppy cultivation was being gradually reduced. With proper attention given to the cultivation of the poppy and the curing of the opium, there was no apparent reason why a drug equal to the Persian should not be procurable.

It was almost superfluous to say that the war had caused an increased demand for anaesthetics, antiseptics, antitoxins, and surgical dressings. It would be generally expected that some at least of the substances heretofore made exclusively in enemy countries would in future be produced in British factories, but many details might have to be worked out and special plant elaborated. Also a manufacturer would not readily take up a new line of business if there were a probability that at the end of the war he would not be in a favourable position to compete. This would be best met by an import duty adjusted from time to time to meet the requirements of the case.

Mr. RUTHERFORD HILL said that the cost of pure ethyl alcohol was so high, owing to the restrictions imposed for revenue purposes on its production and distribution, as to interfere with chemical research and prevent the development of chemical manufactures in this country. Many of the existing restrictions could safely be lessened or removed, and since pure methyl alcohol was really non-potable, it should be non-dutiable so that it could be freely used in the production of

formaldehyde and in many other chemical processes. He urged that Parliament should be approached with a view to these suggestions receiving legislative sanction. It had been pointed out that the security of the national revenue of this country depended on the population retaining their habit of using alcohol and tobacco. The annual revenue from alcohol being something like twenty-one millions a year, it would be very difficult to get any Government to give alcohol for commercial purposes duty free. Ethyl alcohol itself ought to be producible much cheaper than it is just now. One large maker recently stated that he could produce pure alcohol at 6d. per gallon if the restrictions of the Revenue authorities were reduced. Cheaper materials might also be used for the production of alcohol. Attempts had been made in this country to use beetroot and potatoes for the purpose, but they had not succeeded. If we could get a cheap enough supply of ethyl alcohol it would be possible to produce our own acetone by the oxidation process, which it was impossible now to do economically. It was to be hoped that the Government would be much more ready than hitherto to allow the use of more suitable denaturants adapted to particular products. The Government should be ready to subsidise any industry which could make out a good case.

Mr. J. F. BRUGES said that the chief concern of the paper industry in the East of Scotland was to keep the esparto trade intact. The Germans thoroughly appreciated the fine qualities of esparto papers, without having, so far, been able to establish their successful manufacture on any appreciable scale. The high standing of English papers in Germany was illustrated by the widespread manufacture of papers in that country bearing fraudulent English water-marks. In attempting to capture German trade it appeared undesirable to devote attention to specialities which were protected by favourable German natural conditions, such as were assured them by the fact that they grew their own wood and were able to select and boil it in the best way to produce desired results. The manufacture of the very cheap "grease-proof" imitation parchment papers came under that category. He saw no reason why part of the trade in the chemically treated parchment papers should not be captured. As regarded filter papers, to some extent they depended on the use of very pure water, and their paper mills were rather badly off generally in that respect. They were very hard hit in the way of dyestuffs, and might have to revert to the old wood extracts and mineral pigments. He agreed that there was a want of frankness on the part of our industrial press. Too little space in our trade journals was devoted to the discussion of technical and scientific questions by genuinely "inside" contributors. Compared with the Germans our industrialists were too inarticulate. The difference between British and German industry was mainly one of "outlook." Our manufacturers, with a few exceptions, were apt to place themselves too much in the hands of the practical man with his past experience. The spirit required for the development of a large British industry in dyestuffs and fine chemicals was that which put the study of first principles before accumulated experience.

Mr. STEWART said that the linoleum and floor-cloth industry had been affected by the war, more especially in regard to pigments made from dyestuffs, some of which had hitherto come direct from Germany, while others had been made in this country from imported dyestuffs. They used especially a very strong red for making Turkey red carpet effects, and were searching now for substitutes. They also used large quantities of vegetable black, which some years ago they bought

entirely from Scotland, but it contained from 2½ to 13% of tarry matter, so that the black would not dry, and in certain goods remained soft, whereas the adjacent pigments were quite dry. A German firm had offered them vegetable black, calcined free from tarry matter, at exactly the same price. The local manufacturer said he could not produce such a product unless at a much higher price than formerly, so they had to get their supply from Germany. Since the war they had been able to get it from a source in England, but at an enhanced price. On the other hand, they found they could buy ultramarine just as cheaply and as good in this country as in Germany. The only other pigment with which they had had any trouble was Prussian blue, which was scarce owing to the want of potash salts. The question whether Prussian blue could be made with soda was a matter for manufacturers. One manufacturer said it would not be so strong.

Mr. TATLOCK, speaking from the laboratory glass apparatus makers' point of view, said that British manufacturers were finding it exceedingly difficult to replace German and Austrian products. The total amount of laboratory glass consumed was so small, compared with the other glass products required just now, that it was exceedingly difficult to induce manufacturers to take it up at all. It was hoped in a short time to have porcelain and glassware on the market which would compare not unfavourably with the German products. There was one great difficulty in competing with the German firms owing to their labour conditions which our people would find it impossible to touch. For instance, in one case recently they had found that the porcelain was made in the workers' houses in Germany. There were no such factory acts as our works had to labour under. With such conditions, of course, it was quite impossible to compete in this country. Professor Henderson had referred to the possibility of people buying more readily goods of British manufacture. They did not find that to be the case. The goods had to be cheaper or better; they would certainly never be bought purely because they were British, and he did not altogether think that they should be bought for that reason. Perhaps it was best to continue to buy the best and the cheapest article, no matter its source.

Principal LAURIE, in replying to the discussion, said that our scientific laboratories should be used to solve problems for our manufacturers. At the present time the whole time of our chemists was taken up with routine business, and they had no time for other problems. Until manufacturers realised the value of chemists we should not make much real progress against the competition we should have to face from Germany as soon as the war was over. He did not think the Government could be expected to assist every industry as it had done the aniline dye industry. We are the textile manufacturers of the world, and the stoppage of dyes meant a very great crisis, and in that case the Government were well justified in coming forward. Some pluck and enterprise on the part of our manufacturers was needed. We had the cheapest coal and many other facilities, and surely we could turn out an article, except in certain set cases, at the same price as the German manufacturer.

created by the war. He said that in his opinion there should be established a research laboratory separate from the laboratories in the country, which might be called a "Central State Research Laboratory." In the present universities there should be courses of three to four years, leading to an honours degree, with a post-graduate course of one year in the methods of research, and such students only should be eligible for nomination by their professors for scholarships in the Central State Research Laboratory. Such nominated and approved students would pass then with scholarships to the State Research Laboratory, where they would work under the control of a board, representing professors and business men, upon the problems of synthetic chemistry, including not only aniline dyes, but also the production of those chemicals which are either already used or would be likely to be of value in medicine. In correlation with this research laboratory would be the chemical works of the country employing the trained research workers and utilising the patented processes evolved in that laboratory under royalty payable to the Government. The scholarships might be of the value of £150 per annum, and any practical valuable discoveries made would not be remunerated to the worker by the Government, but by the enhanced value of such worker to manufacturers. It would, he thought, be necessary to have connected with the research laboratory a works laboratory which should be equipped for proving processes on a scale large enough for commercial tests. When that was done, and it was found that the process was right for commercial purposes, then it would be the business of the Board of Trade to patent the processes, and offer them to all manufacturers in the country who chose to work them by paying a royalty to the Government on each. The research students would be enthused with the idea of turning their attention to practical research, so as not only to obtain the kudos which such a discovery would give them, but to secure good appointments and the financial results which would fairly belong to them. Since war broke out the manufacturing chemists in the country had been endeavouring, with poor success so far, to manufacture many of the products previously obtained from Germany, but they had been handicapped by the lack of experienced technical research chemists who had had a university training in that direction.

## Obituary.

### C. J. EAMES.

Dr. Charles J. Eames died in New York on March 4th, at the age of 83. He was born in Fulham, and studied chemistry in England and Germany, afterwards crossing to New York, where he practised as an analytical and consulting chemist at a time when there were only three other chemists in that city. Later he became identified with the iron industry and invented the "petroleum process" for the reduction of iron, giving a product containing only 0.03% of impurity. During the last 15 years he practised as a consulting chemist in New York City.

### D. A. LOUIS.

The Society has lost another of its original members by the death of Mr. David A. Louis.

## State Research Laboratories.

Speaking at the annual meeting of Messrs. Southall Brothers and Barclay, at Birmingham on March 20th, Sir Thomas Barclay referred to the position in the drug and chemical and allied trades

on March 25th. He studied mining at the Royal School of Mines between 1876 and 1881, acting during the latter part of that time as research assistant to Prof. Frankland. After a short time spent in dyeworks and silver plating works he was, from 1882 to 1886, engaged in work at Sir John Lawes' Experimental Station at Rothamsted. He spent some years subsequently in mining on the Continent and in America, and was also for a short time the manager of metallurgical works. Since 1891 he was in practice as a consulting mining engineer and metallurgist, and from 1893 onwards acted as Assistant Examiner in mining to the Science and Art Department. Louis contributed largely to the literature of mining, ore dressing, and metallurgical operations; he was for a long time a contributor to "The Engineer," and was joint-author of the article on "Miners' Safety Lamps" in Groves and Thorp's "Chemical Technology." He was for many years an abstracter for this

Journal, and served on its Publication Committee from 1912 until his death. His loss will be keenly felt by the Committee, of which he was one of the most active and useful members.

#### R. A. SEYMOUR-JONES.

Lieut. R. A. Seymour-Jones, of the 4th Battalion (Territorial) South Lancashire Regiment, was killed in action on March 27th. He was educated at Wellington College (Salop) and at Leeds University, and prior to the outbreak of war was a member of the chemical staff of Messrs. Joseph Crosfield and Sons, of Warrington. He was joint author with Prof. Procter of papers printed in this Journal on "Acids in tan liquors" and "The estimation of soluble mercuric salts at great dilutions" (see this J., 1910, 1354; 1911, 404). He was 25 years of age.

## Journal and Patent Literature.

PATENT SPECIFICATIONS may be obtained by post by remitting as follows:—

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### I.—GENERAL PLANT; MACHINERY.

*The evaporator and the power problem in electro-chemical plants.* Mantius. See XI.

#### PATENTS.

*Distilling liquids [e.g., oils and tar]; Apparatus for —.* Sir K. I. Crossley and E. Wheeler, Manchester, and T. B. Smith, Silverdale, Staffs. Eng. Pat. 707, Jan. 10, 1914.

To diminish frothing during distillation of mixtures such as oil or tar and water, a horizontal pipe or superheater is placed in the upper part of the still. The pipe is heated by a flame or hot flue gases, considerably above 100° C.; part of the froth is evaporated, and the remainder falls back into the liquid.—W. F. F.

*Sand, stone, grit, or other materials; Apparatus for drying and heating —.* F. M. Andrews, New York, U.S.A. Eng. Pats. (A) 3781 and (B) 3782, Feb. 13, 1914.

(A) THE material is fed on to the centre of a horizontal corrugated rotary dish or disc mounted in a chamber, from the top of which fixed baffle plates or baffles of flexible chain mail project into the grooves. The material moves outwards against a current of hot gases. (B) The inlet pipe for the hot gases extends upwards from the bottom of the chamber, and its upper end is flared and terminates below a deflector fixed on the under side of the rotary member. The material falls from the deflector through the hot gases into a discharge hopper. Part of the hot gas may pass through perforations in the rotary member into the feed hopper containing the freshly supplied material.—W. F. F.

*Dryers; Automatic charging and discharging device for vacuum —.* E. Passburg. Ger. Pat. 280,035, July 28, 1912.

THE drying chamber is provided at each end with a closing device, e.g., a conical valve, which can be rapidly opened and again closed at relatively long intervals. The material enters and leaves the drying chamber through extensions provided with mechanical conveyors, the arrangement being such that there is always sufficient material in the extension to prevent ingress of air into the drying chamber during the short period for which the closing devices are opened. The apparatus is intended especially for fine materials such as starch.—A. S.

*Kilns; Tunnel —.* E. R. Sutcliffe, Leigh, Lancs. Eng. Pat. 4642, Feb. 23, 1914.

IN a tunnel kiln of the type described in Eng. Pat. 14,506 of 1910 (see this J., 1911, 878), fresh air is admitted through openings into the discharge end of the kiln, and a portion of this air is with drawn by a fan and mixed with the gas before it enters the combustion chamber proper.—W. H. C.

*Clarifying liquids containing finely divided matter in suspension; Apparatus for —.* W. McD. Mackey, Leeds. Eng. Pat. 7179, Mar. 21, 1914.

IN apparatus of the type described in Eng. Pats. 11,410 of 1905 and 1327 of 1911 (this J., 1906, 231; 1911, 1299), a circular tank, the bottom of which inclines towards a central sump or well, is divided into compartments by vertical partitions. The cover of the tank also inclines towards the centre and extends downwards to form a central tube, the lower end of which communicates with the different compartments. The liquid is

admitted down the central pipe, flows into the compartments, and escapes through outlets at the top. The sediment falls towards the sump or well and acts as a filter to the inflowing liquid; a sludge-cock is provided for drawing off the contents of the well.—W. P. S.

*Liquids; Apparatus for impregnating—with carbonic acid or other gases.* A. A. Pindstoffe, Frederiksberg, Copenhagen. Eng. Pat. 19,789, Sept. 14, 1914.

THE gas and liquid ascend together through a closed chamber provided with a series of inverted V-shaped partitions, each having one branch perforated, and arranged so that perforated and imperforate portions are superposed alternately. The liquid is discharged at the top, and the separated gas passes to the upper part of a reservoir situated above the impregnating chamber, from which it displaces liquid to supply the latter. When the liquid reservoir contains only gas, communication is opened to an upper supply reservoir from which the liquid passes down into the first reservoir, whilst the gas bubbles up through a perforated partition. Means are provided in the upper vessel for drawing off the air from the top, while the denser gas is led back to the impregnating chamber.—J. F. B.

*Filter.* C. G. Osgood, Assignor to The Montana-Tonopah Mines Co., Tonopah, Nev. U.S. Pat. 1,128,495, Feb. 16, 1915. Date of appl., Aug. 20, 1913.

RECTANGULAR, tapered, grooved filter-frames, covered with suitable filtering medium, are attached by flange joints to a tubular header, which is connected with a vacuum pump and with a source of compressed air.—W. H. C.

*Liquids of different specific gravity; Apparatus for separating the specifically lighter liquid from a mixture of —.* B. Lorenzen, Ger. Pat. 280,986, March 17, 1914. Addition to Ger. Pat. 266,575.

THE apparatus described in the chief patent (this J., 1914, 14) is modified in that the overflow opening for the lighter liquid diminishes in section from the top downwards, or several openings are provided at different levels, each smaller than the next higher one. The separating vessel is fitted with one or more perforated partitions between the inlet and the overflow opening for the lighter liquid.—A. S.

*Drying machine.* The Sherwin-Williams Co. Fr. Pat. 471,616, Aug. 30, 1913.

SEE Eng. Pat. 19,409 of 1913; this J., 1914, 849.

*Filtering process and apparatus.* C. Butters and Co., Ltd. Fr. Pat. 472,014, May 9, 1914. Under Int. Conv., June 11, 1913.

SEE U.S. Pat. 1,100,219 of 1914; this J., 1914, 781.

*Filtering process and apparatus.* C. Butters and Co., Ltd. Fr. Pat. 472,016, May 9, 1914. Under Int. Conv., June 13, 1913.

SEE U.S. Pat. 1,078,794 of 1913; this J., 1914, 13.

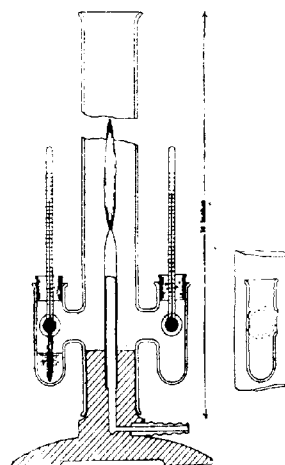
*Apparatus for delivering powdered material into liquids.* Eng. Pat. 3662. See XIXB.

*Process and apparatus for addition of predetermined quantities of substances to a uniform or variable flow of liquid.* Eng. Pat. 4435. See XIXB.

## II.A.—FUEL; GAS; MINERAL OILS AND WAXES.

*Metropolis gas [; Testing of —].* Notification of the Gas Referees for 1915.

THE new features—mainly concerned with the provisions of the Gas Light and Coke Company's Act, 1914—are as follow:—*Illuminating power.* The directions for testing with the Metropolitan Argand Burner No. 2, and with the standard flat flame burner are unaltered, but only those provisions relating to the use of the latter burner are applicable to gas supplied by the Gas Light and Coke Co. If sufficient gas cannot be passed through the flat flame burner to give a light of 8 candles (owing to the increase of density caused by the presence of a large proportion of enriched water-gas in the illuminant), the illuminating power is to be calculated on the basis of the maximum rate obtainable and reported as being less than the resulting figure. *Calorific power.* For gas supplied by the Gas Light and Coke Co., a standard calorific power of 540 B.Th.U., gross, per cub. ft. (at 60° F. and 30 in. of mercury) is required; but the Company is to be penalised only in respect of deficiencies exceeding 7½% of this amount. At each testing place, one test only is to be made daily, unless the calorific power is shown to be below 499.5 B.Th.U., when a second test is to be made, after an interval of not less than 1 hour, and the average of the two results taken as the calorific power of the gas on that day. In the testing places for the South Metropolitan and the Commercial Gas Companies, the calorific power of the gas is to be determined only on such days as the controlling authority shall direct. As heretofore, the Boys calorimeter is specified for use, but the metal vessel of the latter is now jacketed with felt protected by a sheet of metal, the outlet water box protected from loss of heat by a wooden shield made in two halves, and the thermometer for effluent gases supported in one of the five holes by means of a cork and an open spiral of wire, so



that the bulb is a short distance above the circulating coil. The result is corrected for the differences in temperature and humidity between the incoming and effluent gases. For this purpose the

ventilated wet and dry bulb hygrometer (see fig.) is employed, consisting of a single piece of glass, of the shape and dimensions shown, standing on a metal base which, by means of a glass tube, carries a single rat-tail burner adapted to make a flame about 1½ in. high. The air to supply the burner and chimney is drawn through two holes opposite the (Fahrenheit) thermometer bulbs, one of the latter being covered with cotton and connected by means of a wick with the water in the cup immediately below. The instrument is placed near the calorimeter and the ventilating gas flame lighted and adjusted not less than 10 mins. before the calorimeter readings are taken. The directions for ascertaining and applying this correction are:—

The readings of the dry and wet bulbs shall be found in columns 1 and 2 of Glaisher's Hygrometrical Tables, pp. 1 to 28. On the same line in column 7, which is headed 'Vapour in a cubic foot of air,' will be found the number of grains of water contained as steam in a cubic foot of the air entering the calorimeter. Call this *a*. The reading of the meter thermometer shall then be found in both columns 1 and 2, and the corresponding number of grains of water in a cubic foot of the gas will be found in column 7. Call this *b*. The temperature of the effluent gases shall then be found in columns 1 and 2, and the number of grains of water in a cubic foot of these gases will be found in column 7. Call this *c*. On page xiv. of the same Tables, the weight in grains of a cubic foot of saturated air at the temperature of the effluent gases shall also be found to the nearest unit. Call this *d*. Subtract the reading of the dry bulb thermometer from that of the thermometer giving the temperature of the effluent gases, and call the difference *e*. If the effluent gas is cooler than the air entering the calorimeter this difference will be negative in sign. Find the value of  $0.15(0.06-7a-b)+0.00022de$ . The figure so obtained is the number of B.Th.U. to be added [algebraically] to the result obtained directly from the calorimeter in order to obtain the gross calorific power or total heat value of a cubic foot of gas. This correction is based on the assumption that at the rate of burning employed (4–5 cub. ft. per hour) 1 vol. of gas requires 7 vols. of air for complete combustion, and that the products amount to 6.6 vols. The factor 0.15 represents the latent heat of steam in B.Th.U. per grain, and the value 0.00022 the specific heat of the effluent gases per grain per degree F. A copy of the official form with an example of the calculation is appended. The amount of condensed water resulting from the combustion of the gas in not less than 20 mins. is also to be measured, and in the event of the rate of condensation exceeding 150 c.c. per hour, the unions and coils of the calorimeter are to be examined for leakage and the test discarded if the latter is found.—W. E. F. P.

*Coal gas for industrial purposes; Uses of*—  
H. M. Thornton. J. Roy. Soc. Arts, 1915, 63, 401–421.

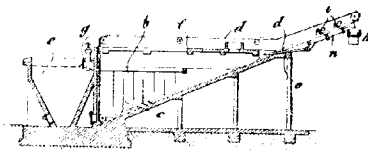
*Mineral resources of German East Africa.* See X.

#### PATENTS.

*Coal washing and clarifying wash water; Process and apparatus for*—C. Burnett, Bath. Eng. Pat. 4688, Feb. 23, 1914.

THE water carrying the fine coal in suspension is received in one of two settling tanks, *b*, provided with baffles or weirs, *c*; the tanks are used alternately. The coal settles on the bottom of the tank and is removed by a scraper-conveyor, *d*, whilst the clear water is run off into a well, *e*. The tanks must be of such a size and extend to such a

height above the overflow, *g*, that they can contain the whole of the water used for washing. As the coal leaves the upper edge of the tank it is drawn



over a fine grid and is simultaneously pressed by two rollers or wipers, *i*, the water which drains from it being passed through the trough, *n*, and pipe, *a*, back to the settling tank. The coal is discharged into a conveyor, *k*.—A. B. S.

*Washing coal or other minerals; Apparatus for*—  
R. H. Reid, Hamilton, N.B. Eng. Pat. 12,990, May 27, 1914.

AN oblong tank with sloping ends is provided with a perforated plate a short distance above the bottom. A current of water flows through the tank, and the coal or the like is delivered on to the perforated plate below the level of the water. Compressed air is introduced below the perforated plate and bubbling up through the perforations assists in the separation of the light and heavy particles.—W. H. C.

*Peat; Apparatus for the treatment of*—T. E. Brown, London. Eng. Pat. 25,962, Nov. 12, 1913.

THE peat passes from a hopper provided with pressing blades and disintegrating knives, to a jacketed cylinder, containing a screw conveyor; in this it is further pulped and then delivered to a moulding box, from which the compressed peat issues as a rectangular mass, which is cut up into blocks.—W. H. C.

[*Briquettes.*] *Composition of matter and process of producing the same.* F. Meyer, Ouray, Colo. U.S. Pat. 1,129,109, Feb. 23, 1915. Date of appl., Jan. 21, 1914.

COAL or coke dust is mixed with a liquid extract of cactus plants and formed into briquettes.—W. H. C.

*Fuel; Agglomerating small particles of*—A. and M. Pidelaserra Brias, Fr. Pat. 472,101, May 11, 1914. Under Int. Conv., May 13, 1913.

CRUSHED or powdered coal, lignite, charcoal, or other fuel is mixed with powdered pitch or coal tar and water, and heated in a kiln until the pitch is coked. The agglomerated fuel is strong and uniformly porous, and its good quality is stated to be largely due to the use of water.—A. B. S.

*Coking retorts, carbonizing chambers, or the like; Vertical*—B. Cochrane, Darlington, and R. Peel, Durham. Eng. Pat. 3886, Feb. 14, 1914.

THE retort is provided with an inner concentric vertical cylinder, completely closed except for openings around the base leading from the annular fuel chamber to gas collecting tubes, which pass upwards through the cylinder and open into the gas space at the top of the retort; the gas is drawn off through a suction main. Firebrick may be packed around the tubes in the inner cylinder and may be heated separately. The retort is surrounded by a brick flue and heated by gas.—W. F. F.



*Coke oven doors and like doors.* H. Gourley, Wombwell, Yorks. Eng. Pat. 6020, March 10, 1914.

THE doors are made of firebrick, ganister, or other refractory material, reinforced with strong vertical bars of wrought iron or mild steel cast in the back portion and with an endless or loop-shaped bar of similar material.—A. B. S.

*Furnace and gas-generator therefor; Combined*—. J. A. Charter, Chicago, Ill. U.S. Pat. 1,128,584, Feb. 16, 1915. Date of appl., Nov. 11, 1912.

SOLID fuel is fed slowly from an external chamber through horizontal pipes with rotating feeding screws, which pass through the furnace. An injector forces the gaseous and solid products through a common opening into the furnace below the pipes.—W. F. F.

*Gas; Apparatus for producing*—[from wood]. W. R. Degenhardt, London. U.S. Pat. 1,128,858, Feb. 16, 1915. Date of appl., Oct. 5, 1914.

LARGE fuel in the form of logs is fed through an opening in the top of a stoking chamber mounted on the generating chamber, whilst small fuel, such as shavings, is delivered through a detachable shoot, constricted at its middle and suspended within the stoking chamber from the opening; the bottom half of the flared lower part of the shoot is perforated.—W. F. F.

*Gas-producer.* G. J. Weber, Kansas City, Mo. U.S. Pat. 1,129,358, Feb. 23, 1915. Date of appl., Oct. 16, 1913.

A CENTRAL core extending upwards into the combustion chamber of a gas-producer has a central air passage discharging into the latter, and means for discharging water into the chamber at a lower level. The core is provided with a cap by means of which a whirling motion is imparted to the air.—W. E. F. P.

*Motor spirit from heavy hydrocarbons; Production of*—. W. A. Hall, New York. Eng. Pat. 437, Jan. 7, 1914. Addition to Eng. Pat. 24,491, Oct. 28, 1913 (this J., 1915, 216).

A HEAVY hydrocarbon oil is cracked above 600° C. and the vapours evolved are condensed under pressure. The uncondensed gases are absorbed in benzol or toluol or a mixture of the two, and the liquid thus obtained is mixed with the condensed liquid to yield a product suitable for use as a motor-spirit.—E. R. A.

*Motor spirit; Production of*—from heavy hydrocarbons. W. A. Hall, New York. Eng. Pat. 7282, March 23, 1914.

To clarify motor spirit obtained by the process described in Eng. Pat. 24,491 of 1913 (this J., 1915, 216), the vapours of the hydrocarbons boiling below 200° C. are passed, immediately after dephlegmating but before condensing under pressure, through a scrubber containing dehydrated fuller's earth, dehydrated bauxite, infusorial earth, or the like.—W. F. F.

*Petroleum distillation.* E. M. Clark, Alton, Ill., Assignor to Standard Oil Co., Whiting, Ind. U.S. Pat. 1,129,034, Feb. 16, 1915. Date of appl., April 20, 1914.

THE distillate from a battery of stills passes to condensers, whence the condensed liquid passes to collecting drums and thence through pipes containing meters to a pair of headers, whilst the uncondensed gas passes from the condensers and

from the upper part of the collecting drums to valved headers where it is confined under pressure the pressure produced at a later stage in the distillation is used to exert pressure on the material at an earlier stage.—W. F. F.

*Fuels of low sulphur content; Process for obtaining*—. A. Fingerland, A. Indra, and A. Lissne Fr. Pat. 471,902, May 7, 1914. Under Int. Conv. June 5, 1913.

SEE Ger. Pat. 270,573 of 1913; this J., 1914, 411

*Coal; Process for the distillation of*—. International Gas Development Co. Fr. Pat. 471,206, April 27, 1914.

SEE U.S. Pat. 1,097,513 of 1914; this J., 1914, 68

*Gas; Manufacture of illuminating*—. Comp. Franç. du Centre et du Midi pour l'Eclairage à Gaz, Paris. Eng. Pat. 4829, Feb. 24, 1914. Under Int. Conv., Feb. 24, 1913.

SEE Fr. Pat. 466,197 of 1913; this J., 1914, 58

*Gas; Manufacture of lighting*—. H. Burgi and C. H. Tenney. Fr. Pat. 471,770, May 4, 1914.

SEE U.S. Pat. 1,120,273 of 1914; this J., 1915, 71

*Gas; Process of making*—. G. M. S. Tall Montclair, N.J., Assignor to Hydrocarbon Converter Co., New York. U.S. Pat. 1,128,549, Feb. 16, 1915. Date of appl., Nov. 13, 1908.

SEE Eng. Pat. 24,109 of 1908; this J., 1910, 11

*Gas producers.* H. F. Smith. Fr. Pat. 472,307, May 16, 1914.

SEE U.S. Pat. 1,098,059 of 1914; this J., 1914, 782

*Gas-purifying apparatus.* H. Dicke, Assignor to Berlin-Anhaltische Maschinenbau-A.-G., Berlin. U.S. Pat. 1,129,558, Feb. 23, 1915. Date of appl., Dec. 6, 1913.

SEE Ger. Pat. 271,122 of 1912; this J., 1914, 472

*Paraffin and like substances and mixtures of such substances with oil; Process for the fractional separation of*—. K. Opl, Assignor to Triester Mineral-Oel-Raffinerie, Trieste, Austria-Hungary. U.S. Pat. 1,128,494, Feb. 16, 1915. Date of appl., Feb. 7, 1912.

SEE Ger. Pat. 262,153 of 1912; this J., 1913, 902

*Apparatus for distilling liquids [oils].* Eng. Pat. 707. See I.

*Process for destroying the malodorous gases and vapours produced in the distillation of ammoniacal liquor.* Ger. Pat. 278,776. See VII.

*Manufacture of ammonium sulphate.* Ger. Pat. 279,953. See VII.

## III.—DESTRUCTIVE DISTILLATION; HEATING; LIGHTING.

*Charcoal; Manufacture of*—. J. Board Agric. 1915, 21, 1032—1037.

IN some recent charcoal burning operations in the Forest of Dean a yield of about 20% of charcoal was obtained from oak. The expenses of

burning vary between 18s. and 25s., and the cost of the wood is about 15s. per ton of charcoal obtained, in addition to which there is the cost of sacks and cartage. In normal circumstances the charcoal sells at 40s. to 50s. per ton in large consignments, though at the present time as much as 70s. to 80s. is being obtained.—J. P. O.

*Sources and industrial uses of beryllium compounds.*  
See VII.

*Application of a variety of selenium particularly sensitive to light to the construction of selenium cells for photometry.* Angl. See XXIII.

#### PATENTS.

*Incandescence mantles and a process and apparatus for the manufacture thereof.* E. L. Knoedler, Gloucester City, N.J., U.S.A. Eng. Pat. 4120, Feb. 17, 1914. Under Int. Conv., Feb. 20, 1913.

INCANDESCENCE mantles are shaped and hardened by directing a hardening flame into the mantle which is placed in a perforated muffle, the number, arrangement and size of the perforations being such that a thin film of hot gases is maintained between the inner surface of the muffle and the mantle. A second muffle may be placed outside the first, whereby a higher temperature and increased hardening effect is obtained.—E. R. A.

*Electric conductors [for incandescence lamps, etc.].* British Thomson-Houston Co., Ltd., London. From General Electric Co., Schenectady, N.Y., U.S.A. Eng. Pat. 4235, Feb. 18, 1914.

A LEADING-IN conductor, composed for example of an alloy of iron and nickel with a copper sheath, may be sealed into glass by first coating it with a layer of a fused borate such as borax. The wire is passed from a reel through a strong solution of the borate and then through a tube heated to 800°–900° C., whereby the coating is dried and fused.—W. F. F.

*Filament for incandescence (electric) lighting [; Metal —] and process of manufacture.* E. Cervenka. Fr. Pat. 471,785, July 19, 1913.

The filament is first covered with oxides of the rare earth metals, and afterwards submitted for a few minutes to a voltage higher than that normally employed for lighting, so as to fuse the oxides and form an adherent film.—B. N.

*Photometers.* Eng. Pat. 6319. See XXIII.

### III.—TAR AND TAR PRODUCTS.

*Peat tar; Composition of —.* E. and F. Bornstein. J. Gas Lighting, 1915, 129, 731.

Tar obtained by destructive distillation of peat, contained 48.5% water; 1.8% boiling between 150° and 170° C.; 4.7% between 170° and 230° C.; 10.7% between 230° and 270° C., and 24.7% between 270° and 330° C. The residual coke amounted to 9.4%. The tar yielded 18% of phenols, 1% of bases, 34% of oils, and 47% of pitch. When the tar was extracted directly with alcohol-ether, 24% of paraffin, m. pt. 65° C., was obtained.

*Use of nickel and its oxides in catalysis.* Senderens and Aboulenc. See XX.

#### PATENTS.

*Ureas of the naphthalene series; Production of —.* Farbenfabr. vorm. F. Bayer und Co. Fr. Pat. 471,933, May 7, 1914. Under Int. Conv., June 21, and Oct. 16, 1913, Jan. 22, Feb. 20, and April 11, 1914.

SEE Eng. Pat. 9472 of 1914; this J., 1914, 825. The aminobenzoyl group may be replaced by other aminoacyl groups, and the process may be applied to derivatives of naphthylaminesulphonic acids as well as of 1.8-aminonaphtholsulphonic acid.

*Nitroaminoanthraquinones; Preparation of —.* Badische Anilin und Soda Fabrik. Ger. Pat. 279,866, July 3, 1913.

THE formaldehyde compounds of  $\alpha$ -aminoanthraquinones or the free  $\alpha$ -aminoanthraquinones in presence of formaldehyde or substances capable of yielding it, are nitrated. The *o*- or *p*-nitroaminoanthraquinones are obtained either in the free state or in the form of their formaldehyde-compounds, which are readily hydrolysed by boiling with dilute alkali.—A. S.

*1-Aminoanthraquinone-2-carboxylic acids and their derivatives; Preparation of —.* Badische Anilin und Soda Fabrik. Ger. Pat. 279,867, Sept. 4, 1913. Addition to Ger. Pat. 247,411 (this J., 1912, 764; see also Addition of May 23, 1912, to Fr. Pat. 425,859, and Ger. Pat. 267,211; this J., 1912, 1174; 1913, 1151).

WHEN the method is applied to  $\beta$ -aminoanthraquinones, condensation is effected without the addition of copper or copper compounds.—A. S.

*Anthracene-1.9-dicarboxylic acid and its substitution products; Preparation of —.* Badische Anilin und Soda Fabrik. Ger. Pat. 280,092, July 11, 1913.

ACEANTHRENEQUINONE or one of its substitution products is treated with a mild oxidising agent, e.g., with manganese dioxide or potassium permanganate in neutral or alkaline aqueous suspension or solution, or with sodium bichromate and glacial acetic acid, avoiding excess of chromic acid. Anthracene-1.9-dicarboxylic acid and anthraquinone-1-carboxylic acid are produced from aceanthrenequinone and may be readily separated one from the other.—A. S.

*Tar; Production of a liquid for heating and lighting from —.* A. Markl. Fr. Pat. 471,506, April 29, 1914. Under Int. Conv., May 2, 1913.

SEE Ger. Pat. 277,502 of 1913; this J., 1915, 218.

*Carbazole-sulphonic acids and process of making same.* A. Schmidt, G. Krönlein, and H. Runne, Assignors to Farb. vorm. Meister, Lucius, und Brünig, Höchst-on-Maine, Germany. U.S. Pat. 1,128,369, Feb. 16, 1915. Date of appl., April 24, 1913.

SEE Eng. Pat. 9960 of 1913; this J., 1913, 972.

*Nitrosulphochlorides of *o*-hydroxycarboxylic acids and their derivatives.* Farbenfabr. vorm. F. Bayer und Co. Fr. Pat. 472,213, May 14, 1914. Under Int. Conv., May 29, 1913.

SEE Eng. Pat. 12,061 of 1914; this J., 1914, 855.

*Anthraquinone; Preparation of —.* Chem. Fabr. Griesheim-Elektron. Fr. Pat. 472,216, May 14, 1914. Under Int. Conv., June 6, 1913, Feb. 14 and Mar. 18, 1914.

SEE U.S. Pats. 1,103,383 and 1,119,546 of 1914; this J., 1914, 826; 1915, 22.

*Apparatus for distilling liquids [tar].* Eng. Pat. 707.  
See 1.

#### IV.—COLOURING MATTERS AND DYES.

*Indigo; Government purchase of* ——. Board of Trade Announcement, Mar. 12, 1915.

HIS Majesty's Government have acquired the greater part of the crop of natural indigo, now coming forward. British dye-using firms desirous of participating in this supply should make early application to the Government brokers, Messrs. Lewis and Peat, 6, Mincing Lane, E.C., who will furnish further particulars, and who are instructed to allocate the amount available among *bona fide* users of dyes as nearly as may be in accordance with their requirements, at prices just sufficient to cover the cost of acquisition by the Government and the expenses of distribution. Priority will be given to Government contractors, and no application will be entertained from dealers other than commission buyers acting on behalf of dye-users.

#### PATENTS.

[Azo] dyestuffs; *Production of fast shades and — therefor.* H. Levinstein, J. Baddiley, and Levinstein, Ltd., Manchester. Eng. Pat. 28,569, Dec. 11, 1913.

New disazo dyestuffs are produced by combining two mols. of resorcinol, *m*-aminophenol, or *m*-phenylenediamine or a substitution product of these substances, or one mol. of any one of them and one mol. of another suitable azo component, with the tetrazo compound derived from an aminoarylacetyldiamine of the benzene or naphthalene series of the general formula  $\text{NH}_2\text{ArCO.NH.Ar'.NH}_2$ . Extremely fast shades are obtained by after-treatment with formaldehyde.—F. W. A.

*Anthraquinone series; Preparation of nitrogenous condensation products [dyestuffs] of the —.* Farb. vorm. Meister, Lucius, und Brüning. Ger. Pat. 280,190, March 19, 1913. Addition to Ger. Pat. 270,789 (this J., 1911, 474).

ESTERS of the  $\alpha$ -anthraquinonylarylglycines obtained as described in Ger. Pat. 270,790 (this J., 1914, 475) are heated with caustic alkalis or alkaline-earths in presence of inert solvents at atmospheric or increased pressure: water is split off and  $\alpha$ -anthra-N-arylpyrrolecarboxylic acids are formed. They are yellow to brown substances which dye wool yellow to blue shades in an acetic acid-acetate bath.—A. S.

*Vat dyestuffs and process of making same.* A. Schmidt, K. Thiess, and E. Bryk, Assignors to Farb. vorm. Meister, Lucius, und Brüning, Höchst-on-Maine, Germany. U.S. Pat. 1,128,358, Feb. 16, 1915. Date of appl., Mar. 3, 1913.

SEE Ger. Pats. 265,195 and 265,196 of 1912; this J., 1913, 1101.

*Indophenolsulphonic acids and process of making same.* A. Schmidt and G. Krönlein, Assignors to Farb. vorm. Meister, Lucius, und Brüning, Höchst-on-Maine, Germany. U.S. Pat. 1,128,370, Feb. 16, 1915. Date of appl., April 24, 1913.

SEE Eng. Pat. 10,875 of 1913; this J., 1913, 974.

*Sulphur dyestuffs and process of making same.* A. Schmidt and G. Krönlein, Assignors to Farb. vorm. Meister, Lucius, und Brüning, Höchst-on-Maine, Germany. U.S. Pat. 1,128,371, Feb. 16, 1915. Date of appl., April 24, 1913.

SEE Fr. Pat. 457,535 of 1913; this J., 1913, 1005.

*Azo colouring matters. Azo dyes.* W. Neelmeier and A. Sigwart, Leverkusen, Germany, Assignors to Synthetic Patents Co., New York. U.S. Pats. 1,128,813 and 1,128,814, Feb. 16, 1915. Date of appl., Feb. 25, 1914.

SEE Ger. Pat. 274,082 of 1913; this J., 1914, 781.

*Vat dyes.* O. Bally, Mannheim, Assignor to Badische Anilin und Soda Fabrik, Ludwigshafen, Germany. U.S. Pat. 1,128,836, Feb. 16, 1915. Date of appl., Aug. 14, 1913.

SEE Eng. Pat. 26,551 of 1912; this J., 1913, 1004.

*Vat dyes and process of making same.* G. Kalischer and D. Nissen, Frankfurt, Germany, Assignors to Cassella Color Co., New York. U.S. Pats. 1,129,574 and 1,129,575, Feb. 23, 1915. Date of appl., June 18, 1914.

SEE Eng. Pat. 1443 of 1914; this J., 1914, 743.

[Azo] dyestuffs; *Production of blue diazotisable —.* L. Cassella und Co. Fr. Pat. 471,779, July 18, 1913.

SEE Eng. Pat. 17,030 of 1913; this J., 1914, 743.

*Azo dyestuffs derived from the arylamides of 2,3-hydroxynaphthoic acid; Production of —.* Chem. Fabr. Griesheim-Elektron. Fr. Pat. 471,799, May 4, 1914. Under Int. Conv., Sept. 19, 1913.

SEE Eng. Pat. 10,085 of 1914; this J., 1914, 915.

*Azo dyestuffs; Production of new diazotisable —.* Farbenfabr. vorm. F. Bayer und Co. Fr. Pat. 471,881, May 6, 1914. Under Int. Conv., May 16, 1913.

SEE Ger. Pat. 273,934 of 1913; this J., 1914, 783.

#### V.—FIBRES; TEXTILES; CELLULOSE; PAPER.

##### PATENTS.

*Paper; Apparatus for boiling and washing rags for use in the manufacture of —.* T. H. Nash, St. Paul's Cray, Kent. Eng. Pat. 6874, Mar. 18, 1914.

THE boiler consists of a water-tight casing in which revolves a cylindrical holder having perforated walls formed with angular or V-shaped corrugations, or with sinuous or semi-circular corrugations, and with imperforate ends. Means are provided for driving the holder by gear-wheels at each end and for supplying steam and rinsing water to the interior of the casing.—J. F. B.

*Paper pulp and feeding stuff from the root-stalks of Brassica species, such as cabbage stumps, etc.* W. Fornoff. Ger. Pat. 279,516, Jan. 17, 1914.

THE material is treated with an alkali and digested with steam or water, preferably under pressure, and the fibrous residue is then separated from the soft pulp by pressing. The pulp is used as a feeding stuff, and the fibrous matter, after further digestion with caustic soda or with water under

pressure, is disintegrated in a beating engine and used alone or mixed with other materials as paper pulp.—A. S.

*Fibrous materials; Apparatus for treating* —. E. D. Jefferson, Boston, Mass. U.S. Pat. 1,128,451, Feb. 16, 1915. Date of appl., Jan. 15, 1912.

THE material is treated in a perforated drum rotating in a closed tank partially filled with liquid which is boiled by steam under pressure. The material is prevented from turning in the drum as it rotates, so that it is alternately subjected to the action of the boiling liquid and of the steam above it. Perforated pipes, open at the ends, are arranged across the drum to assist the penetration of the liquid.—J. F. B.

*Acetyl-cellulose plastics; Process of making* —. W. G. Lindsay, Caldwell, N.J., Assignor to The Celluloid Co., New York. U.S. Pat. 1,128,468, Feb. 16, 1915. Date of appl., Nov. 27, 1911.

ACETYLCELLULOSE soluble in acetone is incorporated with a triarylphosphate having not more than seven carbon atoms in the aryl group, e.g., triphenylphosphate, in the presence of a small proportion of methyl alcohol, and the mixture is heated.—J. F. B.

*Retting of plants, especially textile plants; Chemical process for the* —. V. N. F. Lombard and G. A. F. Lasègue. Fr. Pat. 471,781, July 19, 1913. SEE Eng. Pat. 23,355 of 1913; this J., 1914, 248.

*Cellulose; Purified hydrated* — and method of manufacture. A. Pellerin, Neuilly, France. U.S. Pat. 1,128,624, Feb. 16, 1915. Date of appl., July 8, 1910.

SEE Fr. Pat. 410,776 of 1909; this J., 1910, 811.

*Cellulose esters, cellulose compounds, india-rubber, and other ingredients; Manufacture of substances from* —. L. Collardon, West Bromwich. U.S. Pat. 1,128,851, Feb. 16, 1915. Date of appl., Jan. 20, 1913.

SEE Eng. Pat. 1598 of 1912; this J., 1913, 498.

*Cellulose or cellulosic substances; Preparation of solutions of* — in concentrated hydrochloric acid. R. Willstätter. Fr. Pat. 471,479, April 29, 1914. Under Int. Conv., May 24, 1913.

SEE Eng. Pat. 10,605 of 1914; this J., 1914, 859.

*Methyl alcohol or other volatile substances from wood or other material containing cellulose; Method of producing* —. H. O. V. Bergström, Stockholm, Sweden. U.S. Pat. 1,129,542, Feb. 23, 1915. Date of appl., April 30, 1912.

SEE Fr. Pat. 433,168 of 1911; this J., 1912, 123.

*New substituted ureas [and their use for stabilising nitro-products, e.g., celluloid].* Eng. Pat. 17,501. See XX.

## VI.—BLEACHING; DYEING; PRINTING; FINISHING.

*Peroxis bleaching baths; Prevention of decomposition of* —. V. Wintsch. Rev. Mens. Blanchissage, 1914, 7, 102.

TO prevent the rapid decomposition of alkaline solutions of hydrogen peroxide and other bleaching agents containing active oxygen, the addition of

boron compounds as well as pyrophosphate is suggested. A litre of solution containing 34 grms. of hydrogen peroxide, 1.7 grms. of caustic soda, 30 grms. of sodium pyrophosphate, and 5 grms. of sodium metaborate, had not diminished in available oxygen content after heating to 60° C. for one hour. After keeping at this temperature for 34 hours, a diminution of 84% was noted in the case of a sample which did not contain the metaborate, whereas the above sample had only lost 11.2% of its available oxygen. These additions are also useful for the preservation of neutral or acid baths.—F. W. A.

*Weighting of silk; Determination of* —. P. Heermann and Frederking. Chem.-Zeit., 1915, 39, 149–150.

IN the usual method of determining tin phosphate and silicate weighting the silk is heated with dilute hydrofluoric acid at 50–60° C. (compare this J., 1903, 622, 825, 968): the method is somewhat tedious and special precautions have to be taken to prevent the thermometer being attacked by the acid. The authors have found that silk fibroin may be digested with boiling 2% hydrofluoric acid for 1 hour without appreciable loss of weight and propose the following modified method. The sample is heated with 2% hydrofluoric acid in a platinum dish on the water-bath for 15–20 mins., with occasional agitation, then treated as usual with 5% hydrochloric acid, washed, dried, and weighed.—F. W. A.

*Acid dye bath; Mechanism of the* —. II. M. Fort and D. Swares. J. Soc. Dyers and Col., 1915, 31, 80–83.

IN a previous communication (this J., 1913, 907), one of the authors stated a provisional theory of the acid dye bath. It has been shown that if wool is dyed with colour acids or salts of acid dyestuffs in a bath containing sulphuric acid, more sulphuric acid remains in the bath than when wool is treated, under similar conditions, in a bath containing sulphuric acid alone. This is assumed to be similar to the replacement of sulphuric acid from acid-prepared wool on dyeing with an acid dyestuff. In the acid dye-bath the acid first prepares the wool, combination occurring to a considerable extent at the same time, and then an interchange of acid and dyestuff takes place, the wool combining with the dyestuff and liberating sulphuric acid (free or combined). The view that the absorption of acids by wool is due to additive salt formation has received much support (see this J., 1914, 133). Sisley has compared dyeing phenomena to the formation of substances such as anthracene picric acid, a suggestion similar to the theory advanced. It has further been shown that suppressed amidation of wool results in decreased affinity, and increased amidation in increased affinity for acid dyestuffs (see this J., 1914, 306). The present results confirm the view that the dyestuff and the acid interfere with the exhaustion of each other when used together in the ordinary acid dye bath; this interference is related to their combination with wool, and takes place to such an extent that it may reasonably be assumed to be one of the factors influencing dyeing. The common assumption that sulphuric acid liberates the free colour acid from an acid dyestuff in the ordinary acid dye bath, does not explain the excess SO<sub>4</sub> remaining in the acid dye bath, since this excess is found when picric acid is used. Moreover, when salts of acid dyestuffs are used, the excess SO<sub>4</sub> does not correspond to the amount of sodium sulphate which would be formed if such an interaction occurred. Knecht has shown that the magnesium salt of Crystal Scarlet recrystallises unchanged after heating in strongly acid solution.

Misleading results are obtained from a short laboratory test to estimate the bleeding which would occur under a prolonged treatment. On immersion in cold water, changed twice a day, wool dyed from an acid bath scarcely bled until three days had elapsed, when considerable bleeding occurred, increasing to a maximum in several days, and continuing to bleed after six weeks' immersion. Wool dyed from a neutral bath bled considerably at first; the bleeding gradually diminished after several days, but continued to the end of six weeks. This seems to show that the excess of combined sulphuric acid is first removed from the wool, and as its protective action disappears the dye commences to bleed more rapidly, until eventually bleeding may be more pronounced than in the case of wool dyed from a neutral bath. Further experiments are described in support of the reaction: wool-basic hydrate- $H_2SO_4 + Na$  colour salt  $\rightleftharpoons$  wool-basic hydrate-colour salt  $+ Na_2SO_4$ .—F. W. A.

## PATENTS.

*Vegetable textile fibres for bleaching; Preparation of* — J. L. Jardine, Penicuik, and T. A. Nelson, Edinburgh. Eng. Pat. 802, Jan. 12, 1914.

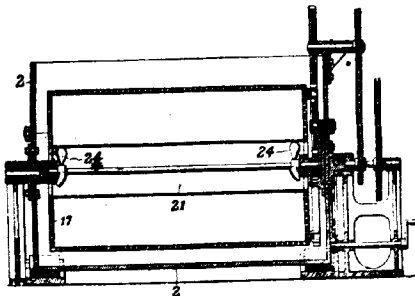
THE material is digested under pressure with a solution of magnesium or sodium bisulphite containing an excess of available sulphurous acid, the gases liberated during the treatment being completely removed to prevent deterioration of the fibre by the liberated sulphur dioxide. This single treatment may be substituted for the alternate alkaline (bowking) and acid (souring) treatments, the lignified incrustations as well as pectose and gummy ingredients being removed without any tendency towards mercerisation, or appreciable alteration of the structural character or strength of the fibres.—F. W. A.

*Bleaching action of hydrogen peroxide or other peroxides, or per-salts; Process for accelerating the* — L. Golodetz and B. Benedix. Ger. Pat. 279,863, Aug. 1, 1912.

THE material to be bleached is treated first with an oxydase preparation, e.g., with an aqueous alcoholic extract of horse-radish, or with yeast or a yeast extract, and then with the bleaching solution.—A. S.

*Dyeing machine.* W. H. Shainline, Norristown, Pa. U.S. Pat. 1,129,128, Feb. 23, 1915. Date of appl., April 10, 1914.

A ROTARY perforated cage, 17, mounted in a tank, 2, for the dye liquor, contains an inner perforated chamber, 21, communicating with the tank by



openings in the ends of the cage. The inner chamber is fitted at each end with a propeller, 24, which can be rotated in either direction. Perforated radial partitions connect the inner and

outer perforated chambers, and divide the cage into separate compartments.—F. W. A.

*Printing of fabrics and other material; Machinery for the intermittent* — E. W. Buckley, and Mather and Platt, Ltd., Manchester. Eng. Pat. 3108, Feb. 10, 1914.

A MACHINE for printing various lengths of fabric, paper, or other material, with means for changing rapidly to deal with varying lengths. A constantly-rotating disc is provided with openings parallel to its axis in which are movable pins. By means of a selective chain device, certain of the pins may be moved so as to project from one side of the disc, whereupon they engage with pawl and ratchet wheel devices which raise and lower the printing rollers.—F. W. A.

*Discharges; Production of coloured* — on tannin-mordanted goods with vat dyestuffs. Kalle and Co. A.-G. Ger. Pat. 280,367, March 7, 1914.

THE tannin-mordanted goods are treated with aluminium acetate solution before being printed with the coloured discharge paste.—A. S.

*Aniline Black; Dyeing* — on tissues and fibres by oxidation with air. A. E. Vergé. Fr. Pat. 471,320, July 7, 1913, and Addition thereto, dated July 18, 1913.

SEE Eng. Pats. 15,668 and 18,246 of 1913; this J., 1914, 418, 747.

*Discharging vat or sulphide colours with reducing agents; Process for* — L. Cassella and Co., G. m. b. H. Fr. Pat. 471,055, July 16, 1913.

SEE Eng. Pat. 17,031 of 1913; this J., 1914, 418.

*Production of fast shades and dyestuffs therefor.* Eng. Pat. 28,569. See IV.

## VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS.

*Sulphuric acid; Fused silica dishes for the concentration of* — A. E. Marshall. Met. and Chem. Eng., 1915, 13, 136—137. (See also this J., 1915, 135.)

FUSED silica dishes for use in continuous cascade concentrating plant were introduced in 1907. This resulted in great fuel economy, as the silica dishes may be exposed directly to the fire gases. The breakage in 15 factories is stated always to be under 5% per annum from all causes, and the fuel consumption 17% of the weight of finished acid. A unit producing 20,000 lb. of acid of 66° B. (sp. gr. 1.842) per 24 hours from acid of 50° B. (sp. gr. 1.53) consists of 100 dishes (12½ in.) and 60 pre-heating pans (24 × 12 in.) in direct contact with the fire gases, except the last three dishes in each row; these are supported in closed seatings to minimise risk of breakage.—W. R. S.

*Steamer carrying sulphuric acid; Loss of a* — Oil, Paint, and Drug Rep., Mar. 15, 1915.

THE steamship "De Sola," which sailed from New York for Great Britain in January with a cargo of concentrated sulphuric acid, carried about 7400 steel drums, each weighing approximately 800 lb., representing about 2800 tons. After the steamer had been eleven days from port, with rough weather, and nearly half-way across, with water in the hold, which had broken through the hatches, it was discovered that the

acid was leaking from the drums, and two men were overcome with gas. It was then deemed advisable to return to the nearest port. Upon reaching St. John's, N.F., the cargo was taken out, and the sound drums carefully re-stowed, but when the steamer was only 24 hours out other steel drums were found to be leaking, and once more the steamer returned to port. While waiting at St. John's for instructions the steamship took fire, as a result of the escape of inflammable gases, and this, together with the damage done to the hull of the ship by the action of the acid, caused the ship to sink. While under water, the drums of sulphuric acid exploded, and the steamer and the cargo are now said to be a total loss.

*Hydrocyanic acid; Determination of small quantities of*—A. Viehoveer and C. O. Johns. J. Amer. Chem. Soc., 1915, 37, 601—607.

THE Prussian-blue method is recommended, the authors having determined the conditions necessary to obtain a constant shade as well as density of colour from a given quantity of hydrocyanic acid. The distillate containing the hydrocyanic acid is rendered slightly alkaline with sodium hydroxide and evaporated under reduced pressure and below 70° C. to a volume of 1 c.c.; 0.2 c.c. of 3% ferrous sulphate solution and 0.05 gm. of potassium fluoride are then added, and the air is exhausted from the flask. After 10 minutes, the mixture is acidified with 30% nitric acid, and the blue coloration obtained compared with a suspension of Prussian-blue made from a known weight of potassium cyanide. The use of nitric acid or sulphuric acid is preferable to that of hydrochloric acid for acidifying the mixture, and the presence of potassium fluoride has a remarkably favourable effect on the formation and colour of the Prussian-blue. It is not necessary to add a ferric salt, and any considerable formation of ferric salts should be avoided.—W. P. S.

*Calcium cyanamide; Crude*—as a raw material of the chemical industry. O. B. Carlson. Baltischer Ing.-Kongress, July, 1914. Z. angew. Chem., 1914, 27, Wirtschaftl. Teil, 724—725.

CRUDE calcium cyanamide has acquired rapidly increasing importance as a raw material of chemical industry. Ammonia is prepared from it by heating with water, and cyanides by fusing with alkali salts; both processes are worked on the industrial scale. By heating with water at moderate temperatures under definite conditions, cyanamide is converted almost quantitatively into dicyanodiamide,  $\text{NH}:\text{C}(\text{NH}_2)_2\text{NH}:\text{CN}$ , and this yields dicyanodiamidine,  $\text{NH}:\text{C}(\text{NH}_2)_2\text{NH}:\text{CO}:\text{NH}_2$ , from which guanidine is prepared technically by heating with acids in an autoclave. Cyanamide when heated with acid yields urea or dicyanodiamide according to the conditions, as is shown in the following table:

Acid.	Temp., °C.	Maximum yield.	
		Urea %	Dicyanodiamide %
10% $\text{H}_2\text{SO}_4$ .....	20	100	0
	50	99	1
	70	48	52
	90	31.5	68.5
20% $\text{H}_2\text{SO}_4$ .....	25	99	1
	50	50	50
	60	7	93
	100	2	98

Thiourea is obtained by the hydrolysis of calcium cyanamide in presence of hydrogen sulphide.

As an example of the use of calcium cyanamide as a raw material for the manufacture of pharmaceutical chemicals, the preparation of veronal (diethylbarbituric acid) is represented schematically. In this process 2-cyanimino-4-imino-5-diethyl-6-oxypyrimidine is produced by the interaction of dicyanodiamide and the ethyl ester of diethylcyanoacetic acid, and is converted into veronal by replacing the cyanimino and imino groups by oxygen. The chief disadvantage attaching to the use of calcium cyanamide as a raw material is its great reactivity, which makes it difficult to obtain high yields and pure products on account of the ease with which secondary reactions take place.

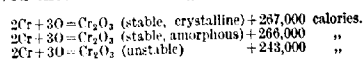
—A. S.

*Ferric salts; Apparent slowness of hydrolysis of*—A. Quartaroli. Gaz. Chim. Ital., 1915, 45, I, 139—152.

THE hydrolysis of ferric chloride in solutions of various concentrations was studied by making determinations of the magnetic susceptibility (due to iron in the ionised condition), electrical conductivity, and concentration of hydrogen ions. It is concluded from the results that the hydrolysed portion of the ferric chloride consists partly of  $\text{FeOH}$  ions (and possibly  $\text{FeO}_2\text{H}$  ions) and partly of amicroscopic colloidal particles of ferric hydroxide or highly basic chlorides: the colloidal particles adsorb a considerable quantity of hydrochloric acid. The proportion of colloidal ferric hydroxide remains unaltered on keeping, but its degree of dispersion diminishes and the resulting decrease of surface causes the liberation of part of the adsorbed hydrochloric acid and hence an increase in the electrical conductivity. With increasing dilution the ionised portion of the products of hydrolysis increases at the expense of the colloidal portion. The magnetic susceptibility measurements are opposed to the view that ferric chloride is completely hydrolysed and converted into the colloidal hydroxide at a dilution of 0.000054 gm.-mol. per litre.—A. S.

*Chromium sesquioxide; Unstable*—and corrections of previous work on the heat effect of chromium and aluminium sesquioxides in fusions with sodium peroxide. W. G. Mixer. Amer. J. Sci., 1915, 39, 295—299.

ETHER the crystalline or the supposedly amorphous modification of chromium sesquioxide when fused with sodium peroxide gave an average exothermal effect of 720 calories per gram: these two stable forms are therefore regarded as the same polymer of the unstable form, the average heat of reaction of which with sodium peroxide was 835 calories per gram. A dark olive-green specimen of the unstable form containing 5.9%  $\text{H}_2\text{O} + \text{CO}_2$  was obtained by dehydrating chromic hydroxide in hydrogen for 24 hrs. at 420° C. but complete dehydration required higher temperatures at which the unstable sesquioxide "glowed" and changed to the stable green oxide. Prolonged heating of the unstable sesquioxide below the temperature of glowing resulted in a similar but slower change, while in a brisk stream of oxygen the change was very rapid at such temperatures. The following derived thermal data are given:



Alumina containing 1.7%  $\text{H}_2\text{O}$  was obtained by maintaining the hydroxide at 500° C. for 24 hrs.; thermal determinations similar to the foregoing indicated that this form polymerises at higher temperatures.—J. R.

*German Potash Syndicate.* Engineering, Mar. 19, 1915.

THE Kali Syndicat has recently forwarded a petition to the authorities asking that permission might be given to raise the maximum prices for the home market fixed in the Kali Law of May 25, 1910. The present condition of the potash industry may be illustrated by the fact that the Anhalt Crown Works have made a loss of 500,000 marks from August to the end of December, whilst the corresponding period of 1913 yielded profits of 200,000 marks. The increase asked for amounts to an allowable limit of 25% during the duration of the war, and six months beyond. In the meantime the board has fixed the production of potash goods for the current year as follows. The figures represent 100 kilos. pure potash:—

	1915.		1914.	
	Home.	Abroad.	Home.	Abroad.
Carnallite with not less than 9% and not more than 12% K <sub>2</sub> O	48,000	3,000	71,000	1,000
Raw products with 12 to 15% K <sub>2</sub> O	2,666,000	822,000	3,390,000	1,411,000
Manure with 20 to 22% K <sub>2</sub> O	20,000	334,000	23,000	483,000
Manure with 30 to 32% K <sub>2</sub> O	36,000	115,000	40,000	164,000
Manure with 40 to 42% K <sub>2</sub> O, including potash manure with 38% K <sub>2</sub> O	2,292,000	687,000	2,113,000	671,000
Chloride of potash	545,000	1,383,000	637,000	1,875,000
Sulphate of potash with more than 42% K <sub>2</sub> O	12,000	376,000	17,000	559,000
Potassium magnesium sulphate	2,000	147,000	2,000	155,000
Total	5,621,000	3,867,000	6,333,000	5,313,000

The quantity to be disposed of for home and abroad for the present year thus amounts to an aggregate of 9,48,600,000 kilos., against 1,166,600,000 kilos. for the preceding year.

*Beryllium compounds; Sources and industrial uses of*—Bull. Imp. Inst., 1914, 12, 613—615.

THE most important beryllium mineral is beryl, a typical analysis of which is: BeO, 12.61; Al<sub>2</sub>O<sub>3</sub>, 17.05; Fe<sub>2</sub>O<sub>3</sub>, 2.20; CaO, 0.57; Na<sub>2</sub>O, 0.68; SiO<sub>2</sub>, 65.24; H<sub>2</sub>O, 2.70%. It is widely distributed and has been found in various parts of the United Kingdom. The treatment of the mineral consists in fusing it with two parts of potassium carbonate for three hours, adding a slight excess of sulphuric acid, evaporating, and diluting with water. The silica is filtered off, the solution concentrated to induce crystallisation of most of the aluminium as potash alum, and the mother liquor poured into a saturated solution of ammonium carbonate, allowed to stand for several days, and then filtered. Basic beryllium carbonate is precipitated from the solution by means of superheated steam and is purified by dissolving in ammonium carbonate and precipitating with steam several times. In an alternative method the beryl is fused with six parts of ammonium fluoride for ten to twelve hours, then extracted with water, the solution evaporated with sulphuric acid, diluted, and treated with ammonium carbonate as above. The only important commercial application of beryllium compounds is the addition of 0.5% of beryllium nitrate to the impregnating solution used in the manufacture of incandescence gas mantles to give

increased strength to the ash skeleton. Prior to the war the manufacture of beryllium nitrate was carried on entirely in Germany, but British manufacturers are now prepared to put beryllium salts on the market.—A. S.

*Hydrazine; Electrolysis of a solution of sodium hydrazide in anhydrous*—T. W. B. Welsh. J. Amer. Chem. Soc., 1915, 37, 497—508.

SODIUM amide or metallic sodium reacted with anhydrous hydrazine, yielding sodium derivatives of hydrazine which could not be characterised on account of their violently explosive nature. Their solutions in anhydrous hydrazine conducted the current, yielding both nitrogen and hydrogen at each electrode. In tests with a copper coulometer the ratio Cu:N varied from 1:1.1 for dilute solutions to 1:2.6 for stronger solutions.—J. R.

*Silicidised carbon. Silfrax.* F. J. Tone. Trans. Amer. Electrochem. Soc., 1914, 26, 181—198.

SILFRAX is obtained by the action of the vapour of silica or silicon on carbon; the product retains the original shape of the carbon, which is penetrated to a maximum depth of about  $\frac{1}{2}$  in. The appearance and character of the product vary with the temperature of production, but non-crystalline (yellow) and crystalline (steel black) varieties, obtained by heating carbon in the amorphous and crystalline zones of a carborundum furnace (i.e., at 1150°—1820° C. and 1820°—2220° C., respectively) were both found to consist essentially of the same silicon carbide as carborundum, viz., SiC. By the combined action of silicon vapour and molten silicon, carbon is silicidised in the same manner as when placed in a carborundum furnace; but the resulting product is carborundum containing varying proportions of pure silicon, these two components being mutually soluble in all proportions. In considering the difference between silfrax and ordinary carborundum, the reactions of the carborundum furnace are discussed, the author being of opinion that the equation,  $\text{SiO}_2 + 3\text{C} = \text{SiC} + 2\text{CO}$ , explains only the conversion of carbon particles into carborundum *in situ*, but not the formation or growth of crystals larger than the original carbon particles, since at the temperature and vapour pressure of the carborundum furnace, carbon is generally regarded as having no appreciable vapour tension. The equation,  $3\text{Si} + 2\text{CO} = 2\text{SiC} + \text{SiO}_2$ , is suggested to account for all the phenomena of the furnace, the forward or low temperature reaction (which is exothermic and occurs throughout the crystalline zone) explaining the building up of the large from the small crystals formed by the first equation, and the reverse reaction (occurring in the hottest part of the furnace and next to the core) explaining the phenomena of the local disappearance and recrystallisation of carborundum. On these grounds, silfrax is regarded as differing fundamentally from carborundum in its mode of production, being formed mainly by the action of silicon vapour on carbon *in situ* and not from gaseous carbon compounds. In the production of silfrax, the density of the original carbon article is such that when the initial coating is formed the pores are almost completely filled with silicon carbide, so that further circulation of gases is made very slow and difficult. Hence the vapour reaction indicated in the second equation cannot occur to any extent, and the crystals remain small and closely compacted so that the product acquires toughness and mechanical strength superior to those of carborundum. Silfrax is used commercially as a refractory material for the manufacture of pyrometer tubes, electrical heating elements, and chemical ware.—W. E. F. P.

*Nitrogen monopoly in Germany.* Chem. and Drug., Mar. 27, 1915.

A GERMAN Reichstag Bill authorises the Federal Council to introduce a commercial monopoly in nitrogen for the period down to March 31, 1922, and to frame the necessary regulations. The monopoly is to apply to (1) inorganic nitrogenous minerals; (2) nitrogenous compounds obtainable from natural products, as well as nitrogen combinations primarily produceable artificially from nitrogen; and (3) nitrogenous fertilisers produced under Nos. (1) and (2) or from other materials. The monopoly would only be extended beyond March, 1922, on the basis of the adoption of a special imperial law. The preamble to the Bill states that German agriculture and industry, particularly the explosives industry, have hitherto been dependent in a great degree upon foreign countries for supplies of nitrogenous compounds, although large quantities were obtained in the country as by-products of coal-combustion. German chemists learned how to make nitrogenous compounds from the air, and after great trouble and financial sacrifices by the Empire and by Prussia, substitutes have been found during the war for the deficiency caused by stoppage of imports of Chile nitrate and other nitrogenous fertilisers, and a nitrogen-industry has been created which can meet the requirements of agriculture and industry in the future. The remunerativeness of the industry after the war must, however, be guaranteed, and this can only be assured by the establishment of a monopoly immediately.

*German Bromine Convention.* Brit. and Col. Drug., Mar. 27, 1915.

It is announced that the mutual agreement hitherto existing between the German Bromine Convention and the Chloride of Magnesium Convention was recently dissolved. The members of the former are consequently now at liberty to produce and dispose of magnesium chloride, whilst it is assumed that some of the members of the Magnesium Chloride Convention who possess bromine plant will also commence to manufacture and sell bromine in the near future. It is considered that the termination of the agreement may cause the prices of both products to fall to the cost of production, with the final result of further prejudicing the position of the potash works concerned, which are already suffering from the unfavourable working and sale conditions prevailing at the present time.

*Export of tin chloride.* Board of Trade Announcement. See X.*Arsenic trioxide from flue dust.* Elton. See X.*Physico-chemical studies on the electrometallurgy of aluminium.* [Melting point and density of mixtures of ergolite, alumina, and calcium fluoride]. Pascal and Jouriaux. See X.*The evaporator and the power problem in electro-chemical plants.* Mantius. See XI.*Catalysis in the oxidation of alkali sulphites.* Saillard. See XVII.*Molecular structure of isotropic and anisotropic binary mixtures [silica-boric oxide glasses].* Tammann. See XXIV.

## PATENTS.

*Nitrogen; Process of fixation of —.* Soc. Générale des Nitrures, Paris. Eng. Pat. 22,596, Nov. 16, 1914. Under Int. Conv., Nov. 21, 1913.

THE impure ferro-aluminium obtained by heating a mixture of bauxite (or other aluminous material), carbon, and metallic iron in an electric furnace, is finely pulverised, mixed with sawdust to render the mass porous, moistened with water, and exposed to the air; the mass becomes gradually and spontaneously heated, combustible gases being evolved, and quickly attains a high temperature, the resulting product being impure aluminium nitride. When once initiated, the reaction may be continued in an atmosphere of pure or impure nitrogen and hastened by blowing air or nitrogen over or through the mass.—W. E. F. P.

*Polishing compositions [mixture of magnesium oxide and a rare earth oxide]; Process of making — and the product thereof.* J. P. Carmichael, Milwaukee, Wis. U.S. Pat. 1,128,287, Feb. 16, 1915. Date of appl., July 17, 1912.

SUITABLE fibre, impregnated with about its own weight of a solution of alkaline-earth or magnesium nitrate (which may also contain a nitrate of a rare earth metal) is dried and calcined, and the ash strongly ignited. The dry product is used for polishing the enamel of teeth, etc.—W. E. F. P.

*Hydrogen peroxide solution.* J. A. Trimble, Brooklyn, N.Y. U.S. Pat. 1,128,637, Feb. 16, 1915. Date of appl., Sept. 4, 1914.

A SOLUTION of hydrogen peroxide containing cinchonidine; for example, one part of cinchonidine to twenty thousand of 3% peroxide solution.—F. SODN.

*Silicates containing potassium and aluminium; Process of decomposing natural —.* Process of producing salts of potassium and aluminium and fixed nitrogen compounds. S. Peacock, Chicago, Ill. Assignor to Internat. Agricultural Corporation, New York. U.S. Pats. (A) 1,129,224, and (B) 1,129,721, Feb. 23, 1915. Dates of appl., July 8, 1912, and Aug. 14, 1913.

(A) THE silicate rock, mixed with carbon, is heated to above 1600° C. in the presence of nitrogen (substantially free from oxygen), and the carbonitrides of potassium and aluminium thus formed are removed by a current of nitrogen. (B) A mixture of carbon and a silicate containing potassium and aluminium is heated in an atmosphere of nitrogen to below 1600° C., and the products are collected and heated in the presence of steam.—F. SODN.

*Potassium and aluminium; Process for separating — from their silicate combinations.* S. Peacock, Chicago. Assignor to International Agricultural Corporation, New York. U.S. Pat. 1,129,505, Feb. 23, 1915. Date of appl., July 8, 1912.

SILICATES containing potassium and aluminium are heated with carbon in the presence of nitrogen at 1200° to 1400° C., and the reaction products are distilled off under diminished pressure. (See also following abstract.)—W. H. H. N.

*Silicon compounds and by-products; Process for making —.* S. Peacock, Chicago. Assignor to International Agricultural Corporation, New York. U.S. Pat. 1,129,506, Feb. 23, 1915. Date of appl., July 17, 1912.

A MIXTURE of finely divided felspar and carbon is heated in the presence of nitrogen to 2500° C.



Potassium and aluminium are removed in the form of gaseous carbonitrides, and the residue is further heated to form a compound containing silicon and carbon. The separated potassium and aluminium carbonitrides are treated with superheated steam.—W. H. H. N.

*Phosphorus; Process of separating—*from its phosphate combinations. S. Peacock, Chicago, Assignor to International Agricultural Corporation, New York. U.S. Pat. 1,129,504, Feb. 23, 1915. Date of appl., July 8, 1912.

PHOSPHATES are heated with carbon in an atmosphere of nitrogen at 900°–1300° C. and the reaction products are distilled off under diminished pressure. Carbide of phosphorus is first formed, and is subsequently converted into nitrides.

—W. H. H. N.

*Volatile compounds [phosphorus and carbonitrides]; Mixed—and process of producing same.* S. Peacock, Chicago, Assignor to International Agricultural Corporation, New York. U.S. Pat. 1,129,514, Feb. 23, 1915. Date of appl., April 18, 1914.

PHOSPHATE rock and carbon are mixed in suitable proportions and heated in nitrogen to 1500° C. The resulting phosphorus and carbonitride vapours are removed under diminished pressure and are separated by oxidising the former and passing into water. The carbonitride is decomposed to ammonia by heating the solution to 200° C.

—W. H. H. N.

*Oxides of phosphorus and nitrogen compounds; Process of producing—* S. Peacock, Chicago, Ill., Assignor to International Agricultural Corporation, New York. U.S. Pat. 1,120,722, Feb. 23, 1915. Date of appl., Aug. 14, 1913.

A MIXTURE of natural phosphate and carbon is heated in an atmosphere free from oxygen, and the gases produced are burnt with an excess of air.—F. SODN.

*Boron carbonitride; Process for producing—* S. Peacock, Chicago, Assignor to International Agricultural Corporation, New York. U.S. Pat. 1,129,508, Feb. 23, 1915. Date of appl., Sept. 7, 1912.

BORON oxide and carbon are mixed, briquetted, and heated in nitrogen to form  $B_2N_2C_2N_2$ , which is cooled in the presence of nitrogen.—W. H. H. N.

*Alkali carbonitride; Process for producing—* S. Peacock, Chicago, Assignor to International Agricultural Corporation, New York. U.S. Pat. 1,129,510, Feb. 23, 1915. Date of appl., Sept. 7, 1912.

ALKALI oxide and carbon are mixed, briquetted, and heated in nitrogen to the temperature of formation of the carbonitride, e.g.,  $K_2N_2C_2N_2$ , and the product is cooled in nitrogen.—W. H. H. N.

*Alkaline silicates [sodium silicate]; Solution of—and process of preparing the same.* J. G. Vail, Chester, and J. D. Carter, Lansdowne, Pa. U.S. Pat. 1,129,320, Feb. 23, 1915. Date of appl., Oct. 22, 1913.

A SOLUTION, forming an almost insoluble product on drying, composed of a neutralised solution of a silicate (e.g., sodium silicate) to which has been added a concentrated alkaline solution of a silicate.

—F. SODN.

*Ammonia; Apparatus for condensing—*from a gaseous to a liquid state. H. C. Gardner, Chicago, Ill. U.S. Pat. 1,129,477, Feb. 23, 1915. Date of appl., Nov. 13, 1913.

A COOLING liquid is discharged on to a coil fixed in a vertical plane and provided with an outlet for the condensed liquid at the bottom, an outlet for uncondensed gases at the top, and an inlet for the gas to be condensed at an intermediate point. The lower portion of the coil is connected by a pipe with the portion above the gas inlet, so that partially condensed gases in the lower portion are separated from the liquid and conducted to the upper portion of the coil, where they are further cooled and partly liquefied, and intermingle with the incoming gases.—F. SODN.

*Ammoniacal liquor; Process for destroying the malodorous gases and vapours produced in the distillation of—* J. Becker. Ger. Pat. 278,776, June 21, 1913.

THE gases are burnt in the known manner to yield sulphur dioxide, which is brought into contact with the condensed water from the ammonia still in a trickling tower. The sulphur dioxide reacts with the hydrogen sulphide in the condensed water to form sulphur.—A. S.

*Ammonium sulphate; Manufacture of—* Bambach und Co. Ger. Pat. 270,953, April 23, 1914.

AMMONIUM sulphate is produced by the interaction of an alkaline-earth sulphate and ammonium sulphite or bisulphite or substances capable of yielding the same. The reaction is preferably carried out in a saturated solution of ammonium sulphate, and the alkaline-earth sulphite which is formed is subsequently decomposed with an acid or a solution of an acid salt. When the process is used to recover ammonium sulphate from gases containing ammonia and sulphur dioxide, e.g., in coking installations, gas-works, and the like, the counter-current method of working is adopted.

—A. S.

*Alkali halides; Process for obtaining—*from natural double silicates. R. van der Leeden. Ger. Pat. 278,250, March 24, 1914. Addition to Ger. Pat. 267,867 (this J., 1914, 865).

NATURAL double silicates (e.g., leucite) with or without addition of reducing agents, are treated with a quantity of a halogen sufficient only to combine with the alkali metals, and the whole is heated under pressure. Substances such as silica, alumina, etc., capable of acting as halogen-carriers, may be added.—A. S.

*Crystallising apparatus for potassium chloride solution and other solutions of the potash industry.* W. Häberlein. Ger. Pat. 279,311, Aug. 15, 1913.

THE long crystallising chamber is provided with narrow, vertical cooling boxes and with a trough at the bottom connected with a tubular extension outside the chamber. A mechanical conveyor passes through the trough and the extension. The latter is in two parts, of which one is perforated. The crystals are removed from the trough by the conveyor and are compressed in the first non-perforated portion of the extension, thus preventing outflow of the solution. In the second, perforated portion of the extension most of the solution carried along by the crystals escapes through the perforations, so that comparatively dry crystals are delivered by the conveyor into an elevator adjacent to the end of the extension.

—A. S.

*Potassium salts; Process for cooling hot solutions of — to obtain large crystals.* W. Häberlein. Ger. Pats. (A) 280,089, July 19, 1913, and (B) 280,090, Jan. 21, 1914.

(A) THE solution is cooled in troughs provided with narrow cooling boxes supplied at first with water at a temperature only slightly lower than that of the solution to be cooled. The temperature of the cooling water is then lowered progressively by introducing gradually increasing quantities of cooler water. (B) After emptying a trough, the cold water in the cooling boxes is displaced by warmer water, a quantity of hot water is added, and the hot solution of potassium salts is introduced gradually into the trough; the temperature of the water in the cooling boxes is then reduced progressively by introducing increasing quantities of cooler water.—A. S.

*Alkali chloride solutions; Electrolysis of —, using a mercury cathode and a porous diaphragm.* Hoesch und Co. Ger. Pat. 279,998, April 25, 1913.

THE electrolyte is circulated from the cathode chamber through the diaphragm into the anode chamber, whence it is withdrawn and passed to the saturating apparatus and then back to the cathode chamber; or a portion only of the liquid in the cathode chamber may be circulated in this way.—A. S.

*Seaweeds; Treatment of —.* C. Christiansen. Ger. Pat. 279,312, March 28, 1912.

THE seaweed is fermented with a culture of organisms (chiefly *Oidium lactis* and *Aspergillus glaucus*, with smaller quantities of lactic bacteria) obtained from decomposing seaweed, the cellulose-containing residue is separated and washed with an alkaline solution and with water, and the solution is treated in the known manner for the recovery of alkali salts, pectin substances, etc. Fermentation is preferably conducted under diminished pressure, and the seaweed may be submitted to a preliminary treatment with acid or alkaline solutions.—A. S.

*Hydrosulphites; Preparation of anhydrous —.* Chem. Fabr. Griesheim-Elektron. Ger. Pat. 279,389, Sept. 28, 1913. Addition to Ger. Pat. 267,872.

A MODIFICATION of the process described in the chief patent (see Fr. Pat. 460,610 of 1913; this J., 1914, 76), the last portions of the water being expelled by heating the hydrosulphite at 60°–65° C., in presence of aniline or an equivalent organic base.—A. S.

*Sodium hydrosulphite; Preparation of anhydrous —.* Kinzelberger und Co. Ger. Pat. 280,181, Nov. 16, 1912.

ANHYDROUS sodium hydrosulphite is obtained as an insoluble precipitate by the interaction of zinc hydrosulphite or zinc-sodium hydrosulphite and sodium acetate in alcohol.—A. S.

*Oxides or hydroxides of heavy metals practically free from basic salts; Process for obtaining —.* F. Cochlovius. Ger. Pat. 279,426, May 14, 1913. Addition to Ger. Pat. 272,182 (this J., 1914, 550).

PRECIPITATES of basic salts obtained by treating a solution of a salt of a heavy metal with a quantity of a basic substance at least equivalent to the metal content of the solution, are heated at a moderate temperature, below the boiling point of the salt, e.g., at 500° C., and then lixiviated with water. To effect a separation in the case of solutions of mixed salts, a quantity of basic substance equivalent only to the metal to be separated, is used.—A. S.

*Hydrogen; Production of — from mixtures of carbon monoxide and steam with the aid of a catalyst.* Badische Anilin und Soda Fabrik. Ger. Pat. 279,582, June 24, 1913.

CONTACT masses are used containing activating substances, especially oxygen compounds of chromium, thorium, uranium, beryllium, antimony, and the like, or mixtures of these, in addition to the usual catalysts; with such contact masses the reaction is practically quantitative at a relatively low temperature; the contact mass during preparation or use should not be heated above 600° C. Small quantities of carbon monoxide may be readily removed from gaseous mixtures with the aid of the contact masses described.—A. S.

*Hydrogen; Production of — by the action of steam on heated metals.* W. Näher and M. Nöding. Ger. Pat. 279,726, Aug. 7, 1913.

STEAM free from air is superheated to about 1000° C. and passed successively over copper and iron, in the order given, in a retort heated to about 800° C. To regenerate the metals from the oxides produced, the undecomposed steam from the retort is converted into water-gas, which is passed first over the iron oxide and then over the copper oxide. The gases from the retort are led again into the water-gas generator to reduce carbon dioxide to monoxide, and this circulation is continued until the reduction of the metal oxides is complete and carbon dioxide is no longer formed, whereupon steam is again led through the retort to produce hydrogen. Since 1 vol. of carbon dioxide yields 2 vols. of monoxide, the water-gas generator is provided with a valve by means of which a certain proportion of the gas can be withdrawn to be used as fuel.—A. S.

*Radioactive preparation suitable for yielding a solution of thorium-X; Production of a —.* Kunheim und Co. Ger. Pat. 279,956, Nov. 30, 1913.

A PURIFIED neutral solution of radiothorium, containing small quantities of rare earths, is treated with hydrogen peroxide, whereby the radiothorium is precipitated as hydrated peroxide. The precipitate can be readily separated by filtration after standing a short time, and the thorium-X generated by disintegration of the radiothorium can be removed by extraction with a dilute solution of sodium chloride.—A. S.

*Sodium sulphate or the like; Process and furnace for the manufacture of —.* Chem. Fabr. Rhenania, C. Thelen, and F. Wolf. Ger. Pat. 279,997, June 4, 1913.

THE charge is heated in a pear-shaped "pan" mounted horizontally and provided with a screw agitator, and then, by rotating the screw in the opposite direction, is forced rapidly through an opening in the narrow end of the pan into the roaster. The material is delivered on to the circular muffle-hearth of the roaster at the centre and is moved across the hearth to a discharge opening at the periphery by mechanical scrapers.—A. S.

*Magnesium carbonate; Process for obtaining — from minerals containing magnesium and calcium.* A. Hambloch. Ger. Pat. 280,084, Sept. 27, 1913.

MINERALS such as magnesite, dolomite, or magnesium silicates are ignited, with or without addition of lime or limestone, the product is treated with ammonium carbonate solution at the ordinary temperature to dissolve magnesia, and the resulting solution is heated to precipitate magnesium carbonate.—A. S.

*Sulphuric acid; Apparatus for the manufacture of* — E. Packard and Co., Ltd. Fr. Pat. 472,366, May 19, 1914. Under Int. Conv., May 23, 1913.

SEE Eng. Pat. 12,067 of 1913; this J., 1914, 692.

*Acetic acid from acetylene; Process for producing* — C. Hansen and A. Weindel, Leverkusen, Germany, Assignors to Synthetic Patents Co., New York. U.S. Pat. 1,128,780, Feb. 16, 1915. Date of appl., Jan. 16, 1914.

SEE Fr. Pat. 467,515 of 1914; this J., 1914, 830.

*Titanium oxygen compounds; Manufacture of — from ilmenite, titaniferous iron ores, and other titaniferous materials.* P. Farup, Trondhjem, Norway. Eng. Pat. 15,680, June 30, 1914. Under Int. Conv., July 1, 1913.

SEE Ger. Pat. 276,025 of 1913; this J., 1914, 920.

*Hydrogen; Process of producing* — A. Mittasch and C. Schneider, Assignors to Badische Anilin und Soda Fabrik, Ludwigshafen, Germany. U.S. Pat. 1,128,894, Feb. 16, 1915. Date of appl., Oct. 20, 1913.

SEE Fr. Pat. 463,114 of 1913; this J., 1914, 313.

*Hydrogen from iron ore and steam; Reducing and oxidising apparatus for generating* — H. Dicke, Assignor to Berlin-Anhaltische Maschinenbau-A.-G., Berlin. U.S. Pat. 1,129,559, Feb. 23, 1915. Date of appl., Dec. 6, 1913.

SEE Eng. Pat. 28,390 of 1913; this J., 1914, 256.

*Ammonia; Production of* — C. Bosch and A. Mittasch, Assignors to Badische Anilin und Soda Fabrik, Ludwigshafen, Germany. U.S. Pat. 1,128,843, Feb. 16, 1915. Date of appl., Nov. 11, 1912.

SEE Eng. Pat. 3345 of 1912; this J., 1912, 1031.

*Peroxide of hydrogen; Process of making* — F. Fischer, Charlottenburg, Assignor to Henkel und Co., Dusseldorf, Germany. U.S. Pat. 1,128,966, Feb. 16, 1915. Date of appl., May 7, 1913.

SEE Eng. Pat. 8582 of 1913; this J., 1913, 791.

*Silicon carbonitride, aluminium carbonitride, and calcium carbonitride; Process of producing* — S. Peacock, Chicago, Assignor to International Agricultural Corporation, New York. U.S. Pats. 1,129,507, 1,129,509 and 1,129,511, Feb. 23, 1915. Dates of appl., Sept. 7 and 19, 1912.

SEE Eng. Pat. 11,390 of 1912 and Fr. Pat. 458,168 of 1913; this J., 1913, 699, 1067.

*Nitrogen compounds; Manufacture of* — T. Fujiyama. Fr. Pat. 471,377, April 27, 1914.

SEE U.S. Pat. 1,126,000 of 1915; this J., 1915, 283.

*Fluoric acids; Preparation of salts of complex* — Gebr. Siemens und Co. Fr. Pat. 471,482, April 29, 1914. Under Int. Conv., April 30, 1913.

SEE Ger. Pat. 279,011 of 1913; this J., 1915, 230.

*Electric furnace. Process of making [nitrogen] compounds in electric furnaces.* U.S. Pats. 1,129,512 and 1,129,513. See XI.

## VIII.—GLASS; CERAMICS.

*Silicidised carbon. Silfrax. Tone.* See VII.

*Molecular structure of isotropic and anisotropic binary mixtures [silica-boric oxide glasses].* Tam-mann. See XXIV.

### PATENTS.

*Tunnel kiln for glazing and enamelling tiles and for like purposes.* G. Andina, Turin, and J. W. Bottomley, Leeds. Eng. Pat. 6818, March 18, 1914.

THE kiln contains several tiers of muffles arranged longitudinally, separated by flues, and surrounded at their middle portions by a series of transverse heating-chambers through which the gases from an adjacent furnace are led in zig-zag fashion around the tiers towards the charging end of the kiln. The supply of air to the various flues is so controlled that the charge in each muffle attains a maximum temperature at the middle of the kiln and is gradually cooled towards the discharge end. —W. E. F. P.

*Refractory materials with a basis of mollen bauxite.* N. Lecesne. Fr. Pat. 471,513, April 29, 1914.

ANTHRACITE is mixed with three times its weight of bauxite and heated in a furnace by an air blast at a pressure of 50 grms. (1 m. water column) to start and gradually rising to 200 grms. or even to 500 grms. The temperature rises rapidly, the charge decrepitating strongly until the combined water has been removed, and with the formation of aluminium carbide the mass becomes incandescent, the silica is volatilised, and the iron is reduced and thrown off as sparks. The heat of reaction is sufficient to raise the temperature of the charge to about 3000° C. and to melt the bauxite completely. Blowing is continued until nearly all the anthracite has been burned off and to cool the charge, which is afterwards removed and crushed, and freed from iron by means of magnets. The product is very porous and of low density (1500 to 1700 grms. per litre). To make impervious refractory articles, it is mixed with water, ground quartz, and a little quicklime; the two last combine and form a bond. For porous refractory goods, finely ground, pure, raw bauxite is used as bond, e.g., 3 to 9 vols. of fused bauxite to 1 vol. of raw bauxite. The mixture is shaped by means of powerful presses, then dried and burned; the finished goods may be used for making abrasive wheels. —A. B. S.

*Porcelain insulators; Method of manufacturing* — W. Boehm, Charlottenburg, Germany. U.S. Pat. 1,128,747, Feb. 16, 1915. Date of appl., Feb. 24, 1913.

SEE Fr. Pat. 462,857 of 1913; this J., 1914, 321.

*Enamel, glass, and the like; Manufacture of white* — I. Kreidl, Vienna. U.S. Pat. 1,128,691, Feb. 16, 1915. Date of appl., March 15, 1913.

SEE Addition of Jan. 18, 1913, to Fr. Pat. 438,908 of 1912; this J., 1913, 753.

*Enamel; White* — I. Kreidl, Vienna. U.S. Pat. 1,129,300, Feb. 23, 1915. Date of appl., Sept. 20, 1912.

SEE Fr. Pat. 438,908 of 1912; this J., 1912, 643.

*Coke oven doors and like doors.* Eng. Pat. 6020. See IIA.

## IX.—BUILDING MATERIALS.

*Gypsum; The products of dehydration of* —. R. Grengg. Z. anorg. Chem., 1914, 90, 327—360.

THE different products obtained by the dehydration of gypsum may be identified by placing a small quantity of the powder in paraffin oil on a microscope object glass, covering with a cover-glass, and heating. In the case of stucco plaster, steam is evolved and soluble anhydrite, recognisable by its ill-defined contour, is formed. With dead-burnt plaster the same structure of the grains is observed as with stucco plaster, but there is no evolution of steam and no change of optical properties (increase of double refraction, considerable diminution in refraction) such as is associated with the formation of soluble anhydrite. Flooring plaster burnt to the point of sintering has a basic reaction and when it is triturated with water hard grains can be observed, which mostly exhibit strong double refraction, though some may show only slight double refraction or even single refraction; the structural elements of stucco plaster are no longer visible, or, if the flooring plaster has been burned at a relatively low temperature, are present only in a partially sintered form and mostly permeated by isotropic droplets; no steam is evolved on heating. Standard preparations should be made for comparison: the pure hemihydrate is prepared by digesting precipitated calcium sulphate with concentrated nitric acid; this yields first soluble and then insoluble anhydrite when heated in paraffin oil on the microscope object glass. Dead-burnt plaster is obtained by heating the hemihydrate in a crucible at a dull red heat, and flooring plaster by heating to incandescence. The author's conclusions in regard to the dehydration of gypsum agree in the main with those of von Glasenapp (this J., 1908, 858).—A. S.

*Plaster of Paris; Hygroscopic and total water in* —. E. Canals. J. Pharm. Chim., 1915, 11, 118—122.

THE uncombined water in plaster of Paris can be determined by drying 5 grms. spread out on a Petri dish, for two hours at 50° C., taking precautions to prevent free access of air to the dried powder before and during weighing. Free and combined water is determined by heating the plaster for a short time at 150° and then for an hour at 300° C. in an Erlenmeyer flask on a sand bath, the sand being piled up to the top of the flask, which must be closed with a cork as soon as the heat is withdrawn and only opened momentarily afterwards in a desiccator to equalise the pressure when cold. Surgical and other fairly pure plasters were found to contain about 1% of hygroscopic water and 6.7—8.1% total water. Samples of lower quality contained less water, generally about 3%.—G. F. M.

*Cement trade of Brazil.* J. Roy. Soc. Arts, Mar. 26, 1915.

THE imports of cement into Brazil have increased from 92,575 tons in 1904 to 260,010 tons in 1910, 364,251 tons in 1912, and 457,986 tons in 1913. The average annual imports from various countries are as follows:—Germany, 129,853 tons; Great Britain, 85,808 tons; Belgium, 54,856 tons; France, 8148 tons; United States, 7160 tons; Denmark 5079 tons; Austria Hungary, 2526 tons. The American brands known as the "Lehigh" and the "Atlas," in barrels of 150 kilos. (about 3 cwt.) are in good demand, at a price of about \$8. 5d. per barrel in Rio de Janeiro. Cement imported from the United States enjoys a reduction of 20% off the Customs duty.

## PATENTS.

*Concrete; Waterproofing and strengthening compound for* —. L. E. Levi, Milwaukee, Wis., Assignor to C. H. Propach, Chicago, Ill. U.S. Pat. 1,128,696, Feb. 16, 1915. Date of appl., Apr. 29, 1912.

CALCIUM chloride is added to a solution containing 30 parts of resin dissolved in sodium carbonate, 70 of soap, and 5 of carnauba wax; the precipitate is filtered off, dried, and pulverised for use. —W. E. F. P.

*Slag; Process for preparing* — for the manufacture of mortar, etc. A. Deckers. Fr. Pat. 471,662, March 31, 1914.

GRANULATED slag is mixed with quicklime and the mixture is ground until a portion of the slag is converted into cement and can thus serve as a binder for the remainder, or the grinding may be continued until the whole mass is of the same degree of fineness as cement.—A. B. S.

*Wood; Process of preserving* —. R. I. Smith, Washington. Assignor to M. H. Smith and W. H. Knight, Takoma Park. U.S. Pat. 1,129,430, Feb. 23, 1915. Date of appl., Nov. 7, 1913.

THE wood is soaked in a solution of iron sulphate and then treated with a solution of copper sulphate. —W. E. F. P.

*Wood and other materials; Process for preserving — and rendering them non-inflammable.* G. Clédat. Fr. Pat. 472,172, May 13, 1914.

THE articles are treated with a solution, saturated at 80° C., of equal parts of magnesium silicate, sodium phosphate, and borax, and then coated with water-glass.—A. B. S.

*Cement.* J. H. Amies, Philadelphia. U.S.A. Eng. Pat. 5242, Feb. 28, 1914.

SEE U.S. Pats. 1,087,914 and 1,088,646 of 1914; this J., 1914, 356.

*Stone; Artificial* —. J. Billwiller, Goldach, Switzerland. U.S. Pat. 1,129,000, Feb. 23, 1915. Date of appl., May 18, 1912.

SEE Fr. Pat. 443,991 of 1912; this J., 1912, 1130

*Refractory products.* Comp. Franc. pour l'Exploit. des Proc. Thomson-Houston. Fr. Pat. 471,514, April 30, 1914. Under Int. Conv., May 2, 1913.

SEE U.S. Pat. 1,094,352 of 1914; this J., 1914, 591.

*Apparatus for granulating liquid blast-furnace slag.* U.S. Pat. 1,128,829. See X.

## X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY.

*Ferrovandium; Determination of manganese in* —. W. W. Clark. Met. and Chem. Eng., 1915, 13, 155—156.

0.2 GRM. of finely powdered alloy is dissolved in 5 c.c. of nitric acid (1:1) and 5 c.c. of sulphuric acid (1:1), with the addition of a little hydrofluoric acid if necessary. The solution is boiled vigorously, treated with 10 c.c. of silver nitrate solution (1.25 grm. per litre) and an excess of solid ammonium persulphate, again heated to boiling, and cooled at once in cold water; after adding a

few drops of saturated solution of salt, the permanganic acid is titrated with sodium arsenite solution. If the manganese content be above 5%, the solution is diluted and an aliquot portion treated with silver nitrate and ammonium persulphate. A determination may be made in about 15 minutes.—W. I. S.

[Cyanide treatment of low-grade Cobalt silver ores.] *Mill and metallurgical practice of the Nipissing Mining Co., Ltd., Cobalt, Ontario.* J. Johnston. Trans. Canadian Min. Inst., 1914, 17, 64—92.

CYANIDE treatment of the low-grade ores was adopted in preference to concentration because the higher cost of construction of the plant was more than balanced by the increased extraction; certain arsenic-antimony-silver combinations and decomposed silver minerals found in some veins give poor results by concentration but yield over 90% of their silver to cyanide. The ore is crushed in a 0.25% caustic soda solution with the addition of 5 lb. of lime per ton of ore to facilitate subsequent settling of the slimes. The pulp is ground to slime in tube mills working in conjunction with Dorr classifiers and is then subjected to a wet desulphurising process by passing it first through a tube mill containing ingots of aluminium and then through an aluminium-lined tank in which it is slowly agitated. By this treatment the refractory silver minerals are broken down and the silver left in a spongy metallic state, so that the subsequent extraction by cyanide is accelerated and improved. The slime from the desulphurising apparatus is dewatered in a Butters vacuum filter to remove as much as possible of the caustic soda solution, and is then subjected to cyanide treatment in tanks fitted with mechanical stirrers and with an air-lift device; the cyanide solution contains 0.25% KCN and 0.20% NaOH. 2 tons being used per ton of dry slime, and agitation is continued for 48—60 hours. After settling and withdrawing the clear solution, the residual slime is transferred to a cyanide stock pulp tank and then to a Butters vacuum filter. Silver is precipitated from the cyanide solution by means of aluminium dust (see Hamilton, this J., 1913, 660) and the precipitate is smelted and refined in a reverberatory furnace, yielding bullion 997—999 fine (see Watson, Eng. and Min. J., Dec. 7, 1912). The cost of construction of the plant, which has a capacity of 244 tons of ore per day, was 254,840 dollars (about £53,090), and the working costs are less than 3 dollars (12s. 6d.) per ton, whilst the extraction on ore containing 26 oz. Ag per ton is 92—93%.—A. S.

Lead; Desilverisation of—. F. C. Newton. Amer. Inst. Min. Eng., Feb., 1915. Met. and Chem. Eng., 1915, 13, 181.

ATTEMPTS were made to effect a higher concentration of the silver and reduce the amount of zinc used in the Parkes process by working at a higher temperature with a view to obtain the compound,  $Zn_2Ag_3$  (solidif. pt., 665°C.) in the crust. The tests proved, however, that a higher temperature was prejudicial to the process; the silver content of the crust was lower, dross and blue powder more abundant, the fuel consumption higher, and the life of the kettle shorter, than in current practice.—W. R. S.

Copper anodes; Formation of a badly conducting film on—in copper cyanide solutions. W. L. Miller. Trans. Amer. Electrochem. Soc., 1914, 26, 63—66.

IN thirteen different copper cyanide electrolytes, under similar conditions as regards circulation, films of insoluble copper salts were formed on the anodes as the result of local concentration of copper in the solutions; the current densities at

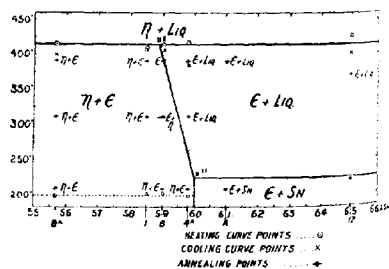
which the films appeared varied in the same manner as the relative amounts of a normal copper salt required to effect a slight precipitation in the electrolytes, and the upper limit of anodic current density economically possible with any similar electrolyte could be ascertained by determining the volume of cupric chloride solution required to produce a precipitate in 5 c.c. of the liquid. The use of a higher current density is rendered possible by addition not only of cyanide but also of ammonia or any other substance capable of keeping the copper in solution.—W. E. F. P.

Corrosion [of brass]; The micro-chemistry of—. Part III. The  $\alpha\beta$  alloys of copper and zinc. S. Whyte. Inst. of Metals, March, 1915. [Advance proof.] (See also this J., 1914, 358; 1915, 258.)

FOUR alloys of copper and zinc containing about 60% Cu were subjected to electrolytic corrosion by an applied electromotive force in sodium chloride solution. One alloy containing only copper and zinc was tested in the unannealed state and also after annealing at 575°C. The other three alloys contained about 1% respectively of Fe, Pb, and Sn, and were all annealed at 575°C. for 1½ hours. The total corrosion of these  $\alpha\beta$  alloys was found to be much less than that of simple  $\beta$  alloys, but more than that of simple  $\alpha$  alloys. Corrosion first proceeded through the  $\beta$  areas and then spread to the  $\alpha$  areas; it still penetrated the  $\beta$  areas in advance after the surface action had ceased. The unannealed alloy was more corroded than the same alloy annealed; iron and lead both accelerated corrosion; tin gave an increase in a five-minute test, and a decrease in a sixty-minute test, due to the retarding action of a tough compact layer of basic salts. In the case of two  $\alpha\beta$  alloys corroded in service, the nature of the corrosion was similar to that induced by an applied electromotive force. "Pitting" is considered to be the result of rapid dezincification, loose porous copper being left behind which is easily removed mechanically.—T. St.

Copper with tin; Constitution of the alloys of—. Parts I. and II. J. L. Houghton. Inst. Metals, March, 1915. [Advance proof.] 23 pages.

THE equilibrium diagrams of Cu-Sn alloys suggested by previous workers, although agreeing in broad outline, differ considerably in several parts of the



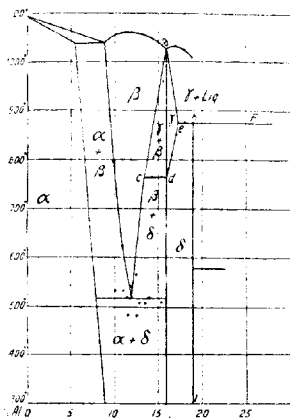
field, notably as regards the range and position of the  $\epsilon$  region, designated H by Heycock and Neville (this J., 1901, 814). The results of the author's study of this region are shown in the accompanying diagram. It is pointed out that neither Shepherd and Blough nor Hoyt (J. Phys. Chem., 1906, 515; this J., 1913, 1112) published any micrographs, so that the evidence for their diagrams cannot be weighed; and that the alloys investigated by Ghilotti and Tavanti (this J., 1908, 1155) were evidently not in equilibrium. According to the present diagram  $\epsilon$  is first formed at

415° C. and Sn 59%, and the point H'' occurs at Sn 60%; whereas according to Heycock and Neville  $\epsilon$  is formed at 400° C. and Sn 61.1% and the line H''H' meets the eutectic line at Sn 65%. The methods employed by Heycock and Neville are criticised and their conclusions regarded as based on scanty and unsatisfactory evidence.

—W. E. F. P.

**Copper-aluminium alloys:** *Some experiments upon* — J. H. Andrews. Inst. of Metals, March, 1915. [Advance proof.] 14 pages.

THE accompanying diagram is suggested for alloys containing up to 20% Al. The existence of the line  $dc$  found by Carpenter and Edwards (this J., 1907,



153, 296) but ignored by Curry (this J., 1907, 1241) is confirmed; it separates the  $\gamma$  from the  $\delta$  phase, whereas the line  $dc$  separates the  $\beta + \gamma$  from the  $\beta + \delta$  phases,  $\delta$  being the  $\gamma^2$  constituent of Carpenter and Edwards. In the author's view, the  $\beta$  constituent (which according to Curry breaks down into  $\alpha + \gamma$  at about 570° C. but according to Carpenter and Edwards exists down to normal temperatures) breaks down into  $\alpha + \gamma$ , and  $\gamma$  afterwards changes into  $\delta$ . The low point at 480° C. and 12.5% Al is due entirely to supercooling caused by retardation of the decomposition of  $\beta$  into  $\alpha + \delta$ ; at 13.5% Al,  $\delta$  is formed directly from the  $\gamma$  constituent previously deposited at 798° C., so that, in alloys containing more than 13.5% Al, free  $\delta$  is already present when the decomposition of  $\beta$  sets in and there is little tendency towards supercooling. The evolution of heat noted by Carpenter and Edwards as occurring at 290° C. in alloys containing 9–16% Al, is confirmed by the author and also regarded as due to supercooling. —W. E. F. P.

**Copper-nickel-cobalt alloys.** M. Waehlert. Oesterr. Zeits. Berg- u. Hüttenw., 1914, 62, 341–346, 357–361, 374–378, 392–395, 406–410. Z. angew. Chem., 1914, 27, Ref. 707–708.

MOXEL metal, an alloy of about Cu 1 and Ni 3 parts, made direct from the Sudbury copper-nickel ores, has found extensive application in the United States, and as the separation of cobalt from the ores makes the cost of production of such alloys excessive, the author examined the influence of cobalt on copper-nickel alloys. It was found that the hardest ternary alloys were those containing nickel and cobalt in equal proportions. The alloys were tolerably resistant to sulphuric acid but were all attacked by nitric acid. —A. S.

**Nickel-aluminium and copper-nickel-aluminium alloys;** *Properties of some [light]* — A. A. Read and R. H. Greaves. Inst. Metals, March, 1915. [Advance proof.] 52 pages.

A DETAILED investigation of the alloys of aluminium with nickel (1.4–4.3%) alone, and with copper (1–4%) and nickel (1–6%) together. All the alloys were easily machinable, but were harder and less ductile the higher the content of copper and nickel; malleability was reduced more by copper than by nickel. By the addition of nickel to aluminium, the maximum stress was increased at the expense of elongation and reduction of area, this being also the case with the alloys containing 1 and 2% Cu; in the 4% Cu series a general deterioration in properties was caused by the addition of up to 3.2% Ni, after which the maximum stress either remained constant or increased. The relative effects of copper and nickel, and the effects of variations in casting temperature and heat treatment of the alloys were also investigated; the conclusion that the properties were unaffected by quenching was confirmed by determinations of the hardness of annealed and quenched specimens. The elastic limit increased with the nickel content in the Ni-Al alloys and in the 2% Cu series, but not in those containing 4% Cu; a diminished resistance to alternating stress generally accompanied an increase in the total nickel and copper content. The specific gravities of the (chill cast) alloys varied from 2.725 to 2.870 (grms. per c.c.); the melting points from 619° to 652° C.; and the electrical conductivities from 46.5 to 55.6 (Cu=100) or from 77.8–93.2 (Al=100). The results of corrosion tests in fresh and sea water, and of microscopic examination of the alloys are also given: the nickel alloys were in all cases more resistant than those containing both copper and nickel.

—W. E. F. P.

**Aluminium:** *Physico-chemical studies on the electrometallurgy of* — [Melting point and density of mixtures of cryolite, alumina, and calcium fluoride.] P. Pascal and M. Joumaux. Rev. Met., 1914, 11, 1089–1093.

THE binary system cryolite-alumina forms a eutectic with  $\text{Al}_2\text{O}_3$  24%, m. pt. 904° C., composed of solid solutions containing  $\text{Al}_2\text{O}_3$  20% and 29% respectively. The system cryolite-calcium fluoride forms a eutectic with  $\text{CaF}_2$  24.4%, m. pt. 905° C., composed of solid solutions containing  $\text{CaF}_2$  20.5% and 50% respectively. The system  $\text{CaF}_2$ - $\text{Al}_2\text{O}_3$  forms a eutectic with  $\text{Al}_2\text{O}_3$  26.5%, m. pt. 1270° C., composed of solid solutions containing  $\text{Al}_2\text{O}_3$  20% and about 28.5% respectively. The ternary system forms a eutectic of the composition cryolite 59.3,  $\text{CaF}_2$  23%, and  $\text{Al}_2\text{O}_3$  17.7%, the melting point being 868° C. The 950° C. isothermal on the derived liquidus roughly forms the boundary of all the mixtures used industrially as electrolytes for the manufacture of aluminium. Density determinations of the systems in the molten state were also made. The density of metallic aluminium at 950° C. is 2.365. Molten cryolite has a maximum density of 2.216 at 995° C., i.e., a little above the melting point. Cryolite with 3%  $\text{SiO}_2$  has a maximum density of 2.150 at 990° C.; with 12%  $\text{CaF}_2$  2.310 at 985° C., and with 25.4%  $\text{CaF}_2$  a maximum of 2.474 at 1000° C. About 15%  $\text{CaF}_2$  suffices to render the melt denser than the molten metal. The effect of added alumina is to lower progressively the temperature at which the maximum occurs. Cryolite with 24%  $\text{Al}_2\text{O}_3$  has a maximum density of 2.260 at 935° C. Of the maxima given by different proportions of alumina, that with 13%  $\text{Al}_2\text{O}_3$  has the lowest value, viz., 2.110, the temperature being about 960° C. With 28%  $\text{Al}_2\text{O}_3$  the value of the

maximum density has risen to that of the metal. The ternary system was also studied, the results serving for the construction of the density surfaces for temperatures between 900° C. and 1100° C. The results show that at 950° C. all the mixtures actually employed have a density not exceeding 2.4. Owing to the inevitable presence of a little silica this figure is never actually reached, the consequence being that the density of the bath never exceeds that of the metal, which therefore collects at the bottom.—T. St.

*Aluminium wire; Electrolytic insulation of*—. C. E. Skinner and L. W. Chubb. Trans. Amer. Electrochem. Soc., 1914, 28, 137—147.

A NON-CONDUCTING film of alumina is produced on aluminium wire used as anode in an aqueous solution of borax, ammonium borate, or sodium silicate, the last giving the best results. The wire is passed continuously at a rate of from 40 to 150 ft. per min. according to its diameter, through a series of five tanks, the first and last of which contain hot water for washing. The consumption of energy varies from 0.15 to 0.80 watt-hour per sq. in. of surface treated; the energy required per unit of surface to bring the wire up to the required voltage (400—425) is less with a high than with a low current density. The non-conducting film, which varies in thickness from 0.0001 to 0.0004 in., is quite flexible and not appreciably weakened by bending, kinking, or stretching the wire; the dielectric strength of the film is high, since two wires, electrolytically treated and then twisted tightly together without abrasion, will stand from 200 to 500 volts without short circuiting. The coating is also fireproof and has sufficient mechanical strength to support the wire in small coils when the metal is above the melting point, the treated wire being thus particularly suited to cases where temperature requirements are severe and insulation requirements not excessive. (See Fr. Pats. 403,234, 419,961, 420,269, and 454,292; this J., 1909, 1317; 1911, 221, 372; 1913, 874.)—W. E. F. P.

*Zinc-lime ore; Leaching a*— with acids. O. C. Ralston and A. E. Gartside. Met. and Chem. Eng., 1915, 13, 151—154.

CERTAIN low-grade zinc ore deposits in Utah are replacements of zinc carbonate in limestone. An ore containing Zn 15.7, CaO 12.96, Fe 4.19, Pb 0.53, and Ag 0.30%, with Au 0.24 oz. per ton, was crushed to 150-mesh and leached cold with hydrochloric acid and with sulphuric acid in an agitator. The extraction of zinc was about the same by the two acids: 80% of the zinc was extracted with an acid efficiency of 50%, the latter being independent of the concentration. When less acid was used than was required to dissolve all the zinc, zinc and lime went into solution in amounts proportional to the percentages in which they were present in the ore. Tests indicated that it may be possible simultaneously to extract the gold by adding chlorine to the liquor.—W. R. S.

*Tin from tin salts of mineral acids; Electrodeposition of*—. F. C. Mathers and B. W. Cockrum. Trans. Amer. Electrochem. Soc., 1914, 28, 133—135.

NUMEROUS experiments were made with electrolytes containing 4% Sn as chloride, fluoride, perchlorate, or fluoborate with about 1% of the corresponding acid (and in some cases the corresponding ammonium salt also) and 0.05 to 0.5% of one or more of twenty-five different addition agents; a current density of 0.4 amp. per sq. dm. was employed. None of the deposits was entirely satisfactory: the best were obtained at the

ordinary temperature from stannous fluoborate baths saturated with clove oil or containing 0.1% of digitalin, and from stannous perchlorate baths containing 0.1% of phloridizin; these deposits were firm and free from loose projections, but very crystalline.—W. E. F. P.

*Tin, tin ore, and tin chloride; Export of*—. Board of Trade Announcement, March 18, 1915.

THE export of tin, chloride of tin, and tin ore to foreign destinations has been prohibited by Order of Council issued on March 18th. Applications for licences to export these commodities should be addressed on the proper form to the War Trade Department, at 4, Central Buildings, Westminster, London, S.W. Such applications will in general only be entertained if the goods are consigned (a) in the case of export to the Netherlands, to the Netherlands Oversea Trust; (b) in the case of export to the United States of America, to His Majesty's Consul General at New York. Exports to neutral European countries other than the Netherlands will only be sanctioned where the country to which the exports are consigned has prohibited the export of tin, chloride of tin, and tin ore.

*Metals; The wet oxidation of*—. Part III. Corrosion of lead. B. Lambert and H. E. Cullis. Part IV. Passivity. B. Lambert. Chem. Soc. Trans., 1915, 107, 210—218; 218—222.

PURE lead, which has been distilled in a vacuum, corrodes very rapidly when subjected to the action of pure water and pure oxygen within a short time of the distillation of the metal. Tests fail to show the presence of lead in solution before the addition of oxygen, and the rate of corrosion is enormously decreased if such lead is kept for long periods in water in a vacuum before adding the oxygen. The pure distilled lead resembles silver or mercury in appearance and colour, and, if kept for some months, can be exposed to air for many days without appreciable diminution of its brilliant metallic lustre, but more prolonged exposure causes the gradual formation of a dark-coloured oxide on the surface. The solution of the metal, which precedes corrosion, is due to electrolytic action between the electrically different parts of the mass of lead. With the chemically pure metal, the physical heterogeneity (due to the presence of different allotropic modifications) causes part of the mass to be electrically different from other parts, and these differences persist for a long time after its preparation. Hydrogen peroxide, produced in the wet oxidation, is the product of a subsidiary action, and has no direct bearing on the corrosion, though it plays a part in oxidising the monoxide to higher oxides.

Passivity is defined as the production, by some chemical or electrochemical process, of a physically homogeneous layer on the surface of the metal, of which the surface was originally physically heterogeneous. Experiments have shown that it is very difficult to explain the inactivity of the author's pure iron (this J., 1910, 1456), except on the assumption that it has a physically homogeneous, and therefore electrically equable, surface of metallic iron, and consequently possesses no tendency to pass into solution in an electrolyte. In a "bad" batch of iron prepared by the author's method, a very large proportion of the pieces can be made to lose their active character and become non-corrodible by keeping for several months either in dry air or in a vacuum, or by reheating for a long time at about 1000° C. in a current of pure dry hydrogen or in a high vacuum; in the last operation hydrogen is given off in considerable quantities.—B. N.

*Mineral resources of German East Africa.* Bull. Imp. Inst., 1914, 12, 585—599.

THE chief economic minerals of German East Africa are mica, gold, garnet, coal, iron ore, uranium minerals, trona, and salt. The most important deposits of mica are in the Uiguru Mountains, where the biotite gneiss, which is the predominant rock, is cut by numerous veins of pegmatite carrying mica associated with pitchblende, rutherfordine, samarskite, galena, blende, bismuthinite, copper and iron pyrites, arsenopyrite, garnet, and tourmaline. The greenish or greenish-brown mica is of the muscovite variety. It is equal to Indian muscovite and Canadian amber mica as an electrical insulator, but inferior to the best Indian ruby mica. The exports were 153,806 kilos. in 1912, nearly all of which went to Germany.

Alluvial gold deposits have been found in various parts and also gold-bearing quartz veins, but the latter, though fairly rich at and near the surface, are much impoverished even at shallow depths. The total output of gold was 450 kilos. in 1911 and 234 kilos. in 1912.

Garnets of value as gem-stones occur in the south-eastern part of the colony: the exports were 154 kilos. valued at about £576 in 1911, and 8 kilos. valued at £29 in 1912, all of which went to Germany.

Coal occurs in various parts, the most important deposits being in the Karoo beds to the north-west of Lake Nyasa, where in one section a seam 49 m. thick was found with two thin shale partings, 6 cm. thick together. The coal of this seam contains: C, 60.60; H, 3.00; O, 13.00; S, 0.25; H<sub>2</sub>O, 4.33; and ash, 18.50%, and yields 78.7% of coke; the calorific value is 5657 calories. The coal from other seams contains up to 70% of carbon and in some cases as little as 5% of ash.

Iron ore also occurs in various parts. Samples of hematite and spathic iron ores contained 75.75% Fe<sub>2</sub>O<sub>3</sub> and 47.95% FeO respectively. A sample of magnetite contained 65.52% Fe<sub>2</sub>O<sub>3</sub> and 1.85% TiO<sub>2</sub>. Titaniferous iron ore containing up to 25% TiO<sub>2</sub> has also been found.

Specimens of radioactive uranium minerals which have been found had the following composition:—Uraninite (pitchblende): U<sub>3</sub>O<sub>8</sub>, 89.47; PbO, 6.87; CaO, 0.82; SiO<sub>2</sub>, 0.52; FeO, 0.48; ThO<sub>2</sub>, 0.20; H<sub>2</sub>O, 2.03%. Rutherfordine: U<sub>3</sub>O<sub>8</sub>, 88.8; CO<sub>2</sub>, 12.1; PbO, 1.0; FeO, 0.8; CaO, 1.1; H<sub>2</sub>O, 0.7; insol. residue, 0.8%. Samarskite (plumbionilite): Nb<sub>2</sub>O<sub>5</sub>, 46.03; Ta<sub>2</sub>O<sub>5</sub>, 1.20; CO<sub>2</sub>, 13.60; TiO<sub>2</sub>, 0.90; Y<sub>2</sub>O<sub>3</sub>, 14.12; Fe<sub>2</sub>O<sub>3</sub>, 5.72; Al<sub>2</sub>O<sub>3</sub>, 0.17; PbO, 7.55; CuO, 1.21%.

Trona occurs abundantly as a white crystalline crust in Lake Natron, a large soda lake near the northern boundary of the colony: a sample gave on analysis 68.5% Na<sub>2</sub>CO<sub>3</sub> and 29.5% H<sub>2</sub>O. In 1912, 2000 tons of salt was obtained from salt springs in the Ujiji district: the spring water has the sp. gr. 1.1 and contains 11.6% NaCl; it has a strong odour of hydrogen sulphide.—A. S.

*Zinc lead smelting; The commercial aspect of electric —.* W. McA. Johnson. Trans. Canadian Min. Inst., 1914, 17, 107—129.

A DESCRIPTION of the smelting of complex zinciferous copper lead ores, containing also silver and gold, in the Johnson electric furnace, and a comparison with the retort furnace method. The ores are roasted till they contain 4—6% S and then blended to give a mixture containing Zn, 15—40; Pb, 5—30; Cu, 1—5; Fe, 10—20; S, 3—7; SiO<sub>2</sub>, 10—30; Al<sub>2</sub>O<sub>3</sub>, 3—5; and CaO, 3—7%. This is mixed with about 15% of soft coal and deoxidised and preheated in a muffle

furnace of the Hasenclever type, a final temperature of 850°—1040° C. being attained. From the preheater the charge is fed continuously into the electric furnace, which is of the buried arc type with the electrodes submerged in the slag and charge, and in which a temperature of 1225°—1250° C. is maintained in the fusion zone. In the preheater calcium and barium sulphates are converted into sulphides, and zinc sulphate into oxide, whilst ferric and copper oxides are reduced; 90—99% of the ferric oxide is reduced to metal. In the electric furnace the products are copper matte containing some of the silver and gold, lead bullion, and slag, whilst the reduced zinc passes as vapour through a brick-lined flue to a condenser. The metallic iron and copper act as deoxidising and desulphurising agents on the gases in the fusion zone of the furnace, and under these conditions up to 90% of the zinc vapour is deposited in the condenser in the molten metallic form. A highly fluid slag is produced which readily separates from the matte and base bullion. The average results of the analysis of about 6000 lb. of the slag were Zn, 0.65 and Cu, 0.12%; Ag, 0.15 oz. per ton; Pb and Au, nil. The electric furnace process possesses the advantages over the retort distillation method that ores containing iron, lime, and silica can be treated successfully; in the treatment of ores containing copper, lead, silver, and gold, these metals are recovered directly in marketable form; the labour cost per ton of material treated is less; the preliminary roasting need be carried on only till the sulphur content is reduced to 4—5%; the cost per ton of treating low-grade ores is less than in the case of high-grade ores, whereas the reverse is true in the retort distillation method. The electric furnace process should be specially serviceable for the treatment of copper-lead ores containing such a large percentage of zinc as to prevent their profitable treatment in the lead blast-furnace, and it may become even a more important factor in lead smelting than in zinc smelting. Some results obtained in practice with the electric furnace are tabulated in the form of a balance sheet, showing the amounts of zinc, lead, copper, silver, and gold charged into the furnace, and the quantities accounted for in the various products.—A. S.

*Metals: The effects of heat and of work on the mechanical properties of —.* A. K. Huntington. Inst. of Metals, March, 1915. [Advance proof.]

ALTERNATING-STRESS tests were made at temperatures up to 343° C. on rods of copper and on an alloy (Cu 95%) in which the added metals (Fe and Ni) were in solid solution; the revolutions for cracking and breaking were plotted against temperature. There appear to be five maxima and five minima in the curves, the curves for breaking and cracking being in every case almost exactly parallel. The lines leading to the maxima and minima respectively are also parallel to each other. The maxima and minima are greatly reduced by annealing, indicating the important part played by "work" in emphasising the transformation points. When plotted together on the same system, there is complete agreement between the alternating bending stress curves and the yield point and reduction of area in simple tension for the same metal. Several of the author's maxima and minima agree with the data obtained by other workers in other ways for various metals and alloys. The author considers that except in the case of phase changes in alloys, mechanical tests are to be preferred to heating and cooling curves as a means of studying changes of state with temperature.—T. ST.



*Etching reagents and their applications.* O. F. Hudson. Inst. of Metals, March, 1915. [Advance proof.]

THE principal reagents which have been found specially suitable for different metals and alloys are the following:—*Copper.* Ammonia, ammonium persulphate, bromine (with ammonia), copper-ammonium chloride. *Brasses.* Ammonia, ammonium persulphate, copper-ammonium chloride, electrolytic etching, ferric chloride, chromic acid, nitric acid. *Bronzes.* Ammonia, ammonium persulphate, ferric chloride. *Copper-aluminium alloys (aluminium bronzes).* Ammonium persulphate, ferric chloride, copper-ammonium chloride, nitric acid. *German silver.* Ammonium persulphate, ferric chloride. *Nickel-copper alloys, monel metal, etc.* Electrolytic etching. *Gold and rich gold alloys, platinum and its alloys, Aqua regia (dilute).* Aluminium and light aluminium alloys. Sodium hydroxide, hydrochloric acid, hydrofluoric acid. *Lead, tin, and their alloys (white metal, etc.).* Chromic acid in nitric acid, ferric chloride, hydrochloric acid, nitric acid, silver nitrate. *Zinc and alloys rich in zinc.* Sodium hydroxide, iodine, Timoféev's reagent (94 grms.  $\text{HNO}_3 + 6$  grms.  $\text{CrO}_3$ ), a few drops in 50 c.c. of water. *Iron and steel.* Copper-ammonium chloride, copper chloride, hydrochloric acid in alcohol, iodine, nitric acid in alcohol, picric acid in alcohol.—T. St.

*Alloys [and other metallurgical products] in the molten condition: Electrical conductivity of —.* E. Bornemann and K. Wagenmann. *Ferrum*, 1914, 11, 276–282, 289–314, 330–343. *Z. angew. Chem.*, 1914, 27, Ref., 707.

FERROUS sulphide has a much higher electrical conductivity than cuprous sulphide.  $2\text{Cu}_2\text{S} \cdot \text{FeS}$  is appreciably dissociated in the fused state even at relatively low temperatures, and the degree of dissociation increases rapidly with rise of temperature. The results obtained with Cu-Sn, Cu-Cd, and Cu-Zn alloys were analogous to those obtained previously by Bornemann and von Rauschenplat (this J., 1910, 884; 1912, 991) with Cu-Sb alloys. The existence of  $\text{Cu}_2\text{Sn}$ ,  $\text{Cu}_2\text{Cd}$ , and  $\text{Cu}_2\text{Zn}$ , was shown on the conductivity and temperature-coefficient curves. In the case of Cu-Al alloys indications were obtained of the existence of  $\text{Cu}_2\text{Al}$  and  $\text{CuAl}_2$  but not of  $\text{Cu}_3\text{Al}$ . The temperature-coefficients of iron and aluminium in the molten condition are very small; that of silver is of the same order as the temperature-coefficients of solid metals.—A. S.

*Mercury, copper, lead, molybdenum, tantalum, tungsten, and silver bromide: Compressibilities of —.* T. W. Richards and E. P. Bartlett. *J. Amer. Chem. Soc.*, 1915, 37, 470–481.

THE compressibilities were determined at 20° C. in a steel piezometer at pressures ranging from 100 to 500 megabars with the following results: Cu 0.76, Pb 2.35, Hg 3.96, Mo 0.47, Ta 0.54, W 0.28, AgBr 2.70. These values, expressed in the megabar standard, multiplied by a million, are referred to the absolute value 0.61 for iron.

—J. R.

*Gases; Determination of — in smelter flues; and notes on the determination of dust losses at the Washoe Reduction Works, Anaconda, Mont.* E. M. Dunn. *Trans. Amer. Inst. Min. Eng.*, 1914, 46, 648–689.

*Oxygen, carbon monoxide, and nitrogen.* Twelve 16-oz. bottles, filled with mercury and supported in a strong, specially designed, two-deck rack, are used for taking samples, the last ten being analysed

in the usual way in a Hempel burette. *Water vapour* is determined by aspirating the gases through a filter of hot glass wool and then through weighed bulbs containing sulphuric acid. *Sulphur dioxide and trioxide and carbon dioxide.* The filtered gas is aspirated through four flasks in series, the first two containing iodine solution (about N/10) and the others a solution of barium hydroxide. The sulphuric acid in the first two flasks is precipitated by barium chloride, and the carbon dioxide is determined by titrating the barium hydroxide solution with standard oxalic acid. *Sulphur trioxide.* The Lunge-Reich and Hempel methods have been discarded in favour of the following method combined with the preceding test. The filtered gases are aspirated through four flasks in series containing weak barium chloride solution and 10–15% of hydrochloric acid. Dissolved sulphur dioxide is entirely removed by boiling, being wholly unoxidised to the trioxide if the solutions are protected from direct sunlight and the light of a free flame. The content of sulphur dioxide is obtained by difference. A specially designed box for carrying the absorption flasks and aspirator is described, and the precautions to be observed are discussed. *Arsenic trioxide* is absorbed in water, two absorption flasks in series being sufficient. Large carbays are used as aspirating bottles to deal with large volumes of gas, and a speed of 25 litres per hour may be used. The tube connecting the first flask with the flue must be washed out with warm sodium hydroxide solution to remove condensed arsenic trioxide. The "sulphate method" is used for the estimation of the arsenic. The following shows the order of the amounts determined:— $\text{SO}_2$  0.423–2.845,  $\text{SO}_3$  0.0044–0.275,  $\text{CO}_2$  0.1136–0.493, water vapour 1.061–3.869,  $\text{As}_2\text{O}_3$  0.00073–0.0156,  $\text{O}_2$  10.18–14.02,  $\text{N}_2$  78.13–83.64%. *Dust losses.* The total volume of gas passing to the stack was determined from the velocity of the gas stream and the cross-sectional area of the free space in the flue. The velocity was measured by Pitot tubes with an Ellison differential draught gauge, and the area of the free space by soundings from holes made in the top of the flue. Dust determinations were made by drawing samples of the flue gas through a finely woven asbestos bag filter by means of an electrically driven rotary blower fan. Runs of 100–120 minutes were made, during which time about 10,000 cb. ft. of gas (standard conditions) passed through the filter, yielding from 400 to 500 grms. of dust. The precautions taken to ensure accuracy, and the methods of calculation are described at length.—T. St.

*Arsenic trioxide from flue dust.* J. O. Elton. *Trans. Amer. Inst. Min. Eng.*, 1914, 46, 690–702.

ARSENIC trioxide is recovered from flue dust or fume by volatilisation, the product obtained by a single roasting or distillation being classed as "crude arsenic." A second distillation gives a refined product often containing 99.97%  $\text{As}_2\text{O}_3$ . Muffle tests in which time and temperature were varied showed that below 1200° F. (649° C.) the proportion of arsenic trioxide recovered is practically constant. Above this temperature lower yields are obtained owing to the formation of arsenates. Roasting with pyrites and powdered coke showed that when arsenic is once "burned in" (i.e., converted into arsenates), it is not liberated again below about 1600° F. (870° C.). The best results are obtained at 950° F. (510° C.) at which temperature arsenic pentoxide and pentasulphide break down and the trioxide is volatilised; only a small amount of sulphur trioxide is liberated, and the metallic oxides have a very low vapour pressure. The gas must be

cooled to 250° F. (121° C.) to obtain complete condensation of the arsenic trioxide. The furnace should have a large capacity; large hearth area, with means for constantly shifting the surface of the dust; intimate contact of the hot gas with the dust, preferably a constant falling of the hot dust through a slow-moving current of the hot gas; continuous operation, with sealed feed and residue-discharge openings; gradually increasing temperature of the dust towards the residue-discharge end. The length of time the dust should remain in the furnace depends on the thickness of the bed of dust and the rabbling it receives; under favourable conditions, the arsenic trioxide is eliminated completely in 30—45 minutes. Rotating cylinder furnaces are suitable, preferably with a dust chamber at the end from which the dust will slide back into the furnace. Multiple hearth furnaces make good first-refining furnaces. Cast-iron hearths give good transference of heat, and at 959° F. (510° C.) the rabble arms and castings do not need cooling.—T. Sr.

*Mineral production of Canada.* J. McLeish. Eng. and Min. J., March 13, 1915.

The preliminary report on the mineral production of Canada in 1914 shows a total value of \$128,475,499, which is a decrease of 11.8% from 1913. This is the first decrease shown in a number of years, and is the smallest total reported since 1911. The subjoined table shows the details of this production.

	1913.		1914.	
	Quantity.	Value.	Quantity.	Value.
		\$		\$
Copper, lb. . . . .	76,976,925	11,753,606	75,738,386	10,991,935
Gold, oz. . . . .	802,973	16,598,923	770,374	15,925,944
Pig iron, tons . . . .	1,128,967	16,540,012	783,101	10,092,856
Lead, lb. . . . .	37,862,704	1,754,705	36,337,795	1,627,568
Nickel, lb. . . . .	49,678,752	14,903,032	45,517,937	13,655,381
Silver, oz. . . . .	31,345,895	19,040,924	27,544,231	15,097,269
Other metallic products . . . . .		1,133,732		1,123,319
Total . . . . .		\$81,904,034		\$67,733,972
Less pig iron exported . . . . .				
ore, tons . . . . .	1,955,459	15,543,589	687,420	8,863,044
Total metallic . . . . .		\$66,361,351		\$58,870,928
		\$		\$
Asbestos, and asbestos, tons . . . .	141,083	3,849,925	117,573	2,909,806
Coal, tons . . . . .	15,012,178	37,334,940	13,594,984	33,433,198
Copra, tons . . . . .	636,379	1,447,739	510,663	1,137,157
Natural gas, m. ft. . . . .	20,477,838	3,309,381	21,047,028	3,511,302
Petroleum, bbl. . . . .	228,080	406,439	214,805	343,124
Pyrites, tons . . . .	158,566	521,181	224,958	735,514
Salt, tons . . . . .	100,791	491,280	107,038	493,648
Cement, bbl. . . . .	8,358,805	11,019,418	7,172,480	9,187,924
Clay products . . . .		9,501,314		7,090,898
Lime, ton. . . . .	7,554,484	1,469,398	6,245,189	1,247,517
Stone . . . . .		5,501,039		5,593,485
Miscellaneous non-metallic . . . . .		4,274,807		3,921,988
Total non-metallic . . . . .		79,273,461		69,605,471
Grand total . . . . .		\$145,634,812		\$128,475,499

The quantity of ores treated by smelters and refiners in Canada in 1914 was: Nickel-copper, 947,053; silver-cobalt, 5661; lead, 71,064; copper-gold, 1,612,197; total, 2,649,935 short tons, a decrease of 387,456 tons from 1913. The first products were 12,238 tons blister copper, 6291 tons copper matte, 46,396 tons nickel-copper

matte, and 101 tons cobalt material. The metallic contents are given in the table below:—

	Refined.	In matte, etc.	Total.
Gold, oz. . . . .	11,088	170,813	181,906
Silver, oz. . . . .	11,096,861	873,400	11,970,261
Lead, lb. . . . .	36,443,706		36,443,706
Copper, lb. . . . .		59,237,016	59,237,016
Copper sulphate, lb. . . . .	152,990		152,990
Nickel, lb. . . . .		45,517,937	45,517,937
Nickel oxide, lb. . . . .	391,312		391,312
Cobalt oxide, lb. . . . .	895,789		895,789
White arsenic, lb. . . . .	3,474,322		3,474,322

*The reproducibility of the copper electrode.* Getman. See XI.

*Flue dust [from iron works] as a manure.* See XVI.

*Constancy of base metal thermocouples as related to the microstructure.* Kowalke. See XXIII.

*Molecular structure of isotropic and anisotropic binary mixtures [gold-silver and gold-copper alloys].* Tammann. See XXIV.

#### PATENTS.

*Cast iron, rod iron or cast steel; Fluxing composition for use in brazing — to cast iron.* J. Abt, Sydney, N.S.W. Eng. Pat. 902, Jan. 13, 1911. Under Int. Conv., Jan. 21, 1913.

A MIXTURE of clean, finely powdered steel or iron, 60; borax, 20; coconut oil, paraffin oil, or vaseline, 10; and methylated spirit, 10 parts. —W. E. F. P.

*Iron or steel: Treatment of — for the prevention of oxidation or rust.* Rudge-Whitworth, Ltd., and H. L. Heatnecote, Coventry. Eng. Pat. 9926, April 22, 1911.

AN iron or steel article which has already been given a phosphatic coating, is treated with linseed oil, either boiled or raw, preferably by spraying, and then stoved at 300—400° F. (149—205° C.). A collodion or celluloid varnish or lacquer may similarly be sprayed on the article; when this is done, the coating may be conveniently, though not necessarily, stiffened by a stoving operation, best carried out in the case of celluloid at not above 110° F. (43° C.). —T. ST.

*Steel: Process for imparting acid properties to molten — in a basic electric furnace.* Elektro-stahl G. m. b. H. Ger. Pat. 279,989, May 12, 1910.

MIXTURES of silica or aluminium silicate with carbon and iron, with or without addition of silicon carbide, are added to the bath in the form of briquettes of sufficient density to sink through the layer of slag. The constituents of the mixture react gradually with one another and with the molten iron, forming ferrosilicon, silicon carbide, and carbon monoxide. The ferrosilicon and silicon carbide dissolve in the molten steel and the carbide reacts with carbon monoxide to form that variety of carbon to which the characteristic properties of steel made in an acid furnace are due. —A. S.

*Steel of good quality and high-grade phosphate slag; Manufacture of — from pig iron of high silicon content.* Deutsch-Luxemburgische Bergwerks- und Hütten-A.-G. Ger. Pat. 280,041, Nov. 30, 1913.

The pig iron is smelted in a basic open-hearth furnace with a sufficient quantity of ore to oxidise

the silicon, but with a minimum quantity of lime, whereby an acid slag, containing most of the silicon but only traces of phosphoric acid, is formed almost immediately; this is removed as quickly as possible and the smelting completed as usual so as to obtain a slag rich in citrate-soluble phosphoric acid. (See also Fr. Pat. 466,016 of 1913; this J., 1914, 600.)—A. S.

*Furnace for annealing metals.* Gibbons Bros., Ltd., and R. Masters, Lower Gornal, Staffs. Eng. Pat. 2866, Feb. 4, 1914.

THE inlets and outlets of the retorts or heating chambers in a close annealing furnace heated by producer gas, are trapped by water seals and are surrounded by a system of flues through which heating gases are passed. The heating gases are led direct to the flues from a combustion chamber (underneath the retorts) to which producer gas and heated secondary air are supplied, and then pass to a stack through a waste heat flue disposed longitudinally between the retorts.—W. E. F. P.

*Muffles or tubes for containing articles to be annealed, or to receive heat treatment.* C. Glossop, Sheffield. Eng. Pat. 9783, April 21, 1914.

CAST-IRON or earthenware muffles are formed with a cylindrical or polygonal interior and longitudinal horizontal flutings on the exterior. At intervals along the exterior are collars or flanges so that the muffle may be turned on its periphery, whilst leaving a space between the fluted portion and the bed upon which the collars rest. Bolt holes formed in the collars allow of any number of units being coupled together lengthwise.—T. St.

*Furnaces; Rabble arms of roasting.*—H. H. Stout, New York. Eng. Pat. 4221, Feb. 18, 1914. Under Int. Conv., Oct. 30, 1913.

THE teeth along each arm are shaped to give both forward and backward movements to the ore, the active forward area becoming progressively less towards the extremity of the arm, so that an equal volume of ore is moved forward by each tooth. The bed of ore is thus kept at a substantially even depth over the entire surface, and every particle of ore remains under treatment for about the same period of time. Slight mechanical differences prevent the teeth from being wrongly assembled.—T. St.

*Separators; Electrostatic—*for sorting out the constituent parts of commodities according to their electric capacity. A. Bibolini, Belluno, and P. Riboni, Naples, Italy. Eng. Pat. 7274, March 23, 1914.

A POLE piece or field plate is arranged above a conveyor of low inductivity, with its faces inclined upwards towards both sides transversely to the direction of travel of the conveyor, its length corresponding approximately to the distance between the feeding and discharging devices. The plate may be made of flexible material, curved, and carried at its longitudinal edges by arms capable of adjustment transversely to the longitudinal axis of the apparatus, so that the curvature of the plate may be varied. The pole piece may also be raised or lowered, parallel to or at an angle with the conveyor band.—B. N.

*Copper from nickel and matte and other products; Separating.*—N. V. Hybinette, Christiansand, Norway, Assignor to National Trust Co., Ltd., Toronto, Canada. U.S. Pat. 1,128,313, Feb. 16, 1915. Date of appl., June 5, 1912.

A SLAB containing copper, nickel, and sulphur, is subjected as an anode to electrolytic action to prepare its surface, and copper is deposited on it,

by cementation, from a solution containing copper and nickel sulphates, the solution becoming simultaneously enriched in nickel.—B. N.

*Copper-nickel anodes; Producing.*—Process of circulating solution for electrolysis. Anode for electrolysis. N. V. Hybinette, Christiansand, Norway, Assignor to Pacific Securities Co., Ltd., Toronto, Canada. U.S. Pats. (A) 1,128,314, (B) 1,128,315, and (C) 1,128,316, Feb. 16, 1915. Date of appl., June 26, 1913.

(A.) COPPER-NICKEL anodes, comparatively poor in copper, are produced from matte and other products comparatively rich in copper. The matte is roasted, and the resulting oxides are leached with dilute sulphuric acid, the solution being then electrolysed to recover copper. The acid solution is crystallised, and the acid mother liquor again used for leaching, whilst the impure crystals of nickel sulphate are mixed with the residue from the leaching process, and the mixture smelted for the production of metal, which is cast into anodes. (B.) In the separation of copper from nickel by electrolysis, the electrolyte is passed alternately into the bottom and top of the cathode compartment, and then circulated through a filter from the cathode to the anode. (C.) A charge of copper-nickel matte containing sulphur is reduced by a blast in a suitable furnace, the charge being proportioned so as to obtain a product containing from 4 to 8% S. The product is cast into slabs, and the surface treated by electrolysis.—B. N.

[Radium, vanadium, etc., from carnotite.] *Metallurgical process.* L. F. Vogt, Washington, Assignor to Standard Chemical Co., Pittsburgh, Pa. U.S. Pat. 1,129,029, Feb. 16, 1915. Date of appl., July 21, 1913.

CARNOTITE ore is roasted with sodium chloride and an oxidising agent, the product treated with water, the solution of sodium vanadate separated, and the residue treated with dilute sulphuric acid to obtain a solution of uranyl and vanadyl salts and a residue containing radium and barium sulphates. The latter is fused with sodium carbonate, the melt extracted with water, the insoluble carbonates dissolved in acid, and the solution precipitated with sulphuric acid and filtered. The precipitate (radium and barium sulphates) is roasted with carbonaceous matter and a chloride, and the product treated with water to obtain a solution of radium and barium chlorides, which are subsequently separated by fractional crystallisation.—W. E. F. P.

*Vanadium ore; Treatment of.*—L. F. Vogt, Washington, Pa. U.S. Pat. 1,129,253, Feb. 23, 1915. Date of appl., Nov. 26, 1913.

THE ore is heated with excess of sulphuric acid or acid sulphate, and the mixture is roasted to expel most of the uncombined acid and then treated with water; the resulting acid solution, containing vanadium and other sulphates, is treated with iron to remove copper and arsenic, and then with alkali to neutralise the remaining acid and precipitate ferrous vanadate. When the latter contains much phosphorus it is fused with sodium chloride to produce sodium vanadate and phosphate, and the mass extracted with hot water, the solution being first treated with an aluminium salt to remove the phosphorus and then with ferrous sulphate to precipitate the vanadium.—W. E. F. P.

*Blast furnaces; Preparing ore for.*—G. L. Collard, Sharon, Pa. U.S. Pat. 1,129,645, Feb. 23, 1915. Date of appl., April 22, 1914.

FINELY divided dry ore is prepared for use in a blast furnace by mixing it with another finely

divided cementitious ore in its natural moist condition and injecting steam into the mixture.  
—T. St.

*Blast-furnace slag; Apparatus for granulating liquid* —. E. Werzner, Troisdorf, Germany. U.S. Pat. 1,128,829, Feb. 16, 1915. Date of appl., March 28, 1914.

WITHIN a casing are two discs operating independently, one of which carries two concentric rows of beater rods, and the other a single row between the first two rows. Slag and cooling fluid are delivered within the rows of beaters, the inlet pipe for the cooling fluid being beneath the inlet shoot for the slag.—T. St.

*Iron alloy.* W. Rübel, Charlottenburg, Germany. U.S. Pat. 1,128,726, Feb. 16, 1915. Date of appl., Oct. 22, 1913.

SEE Eng. Pat. 3445 of 1913; this J., 1914, 318.

*Ores; Chloridising roasting of* —. A. Ramén and K. J. Beskow, Helsingborg, Sweden. U.S. Pat. 1,129,123, Feb. 23, 1915. Date of appl., Aug. 18, 1910.

SEE Eng. Pat. 23,108 of 1909; this J., 1910, 1459.

*Metals, etc., soluble in alkalis; Process of obtaining* —. G. Spitz, Brünn, Austria-Hungary, Assignor to Goldschmidt Definning Co., New York. U.S. Pat. 1,129,431, Feb. 23, 1915. Date of appl., April 21, 1908.

SEE Fr. Pat. 370,986 of 1906; this J., 1907, 257.

*Magnetic separator.* G. Ulrich, Assignor to F. Krupp A.-G., Grusonwerk, Magdeburg-Buckau, Germany. U.S. Pat. 1,129,822, Feb. 23, 1915. Date of appl., July 3, 1913; renewed Jan. 21, 1915.

SEE Eng. Pat. 14,427 of 1913; this J., 1914, 425.

*Electrostatic [ore] separator.* A. Bibolini and P. Riboni. Fr. Pat. 471,657, March 30, 1914. Under Int. Conv., April 28, 1913.

SEE Eng. Pat. 7274 of 1914; preceding.

*Nickel; Recovery of* — from its ores. The Madagascar Minerals Syndicate, Ltd. Third Addition, dated July 4, 1913, to Fr. Pat. 463,615, Dec. 21, 1912.

SEE Eng. Pats. 27,626 of 1912 and 3811 and 6703 of 1913; this J., 1914, 30.

*Tin-plate scrap; Process for delinting* —. Chem. Fabr. von der Linde m. b. H., and G. von der Linde. Fr. Pat. 471,738, May 1, 1914. Under Int. Conv., May 5, 1913.

SEE U.S. Pat. 1,116,176 of 1914; this J., 1914, 1214.

*Zinc; Extraction of* — from its ores or other products containing zinc. The Metals Extraction Corporation, Ltd. Fr. Pat. 472,346, May 18, 1914. Under Int. Conv., Sept. 24 and Oct. 8, 1913.

SEE Eng. Pats. 21,581 and 27,761 of 1913; this J., 1914, 1058.

## XI.—ELECTRO-CHEMISTRY.

*Electro-chemical plants; The evaporator and the power problem in* —. O. Mantius. Trans. Amer. Electrochem. Soc., 1914, 26, 215—226.

THE general conditions governing the efficiency of evaporating equipment are considered in

relation to the production of caustic alkali by electrolytic processes employing steam or water power. The use of a high-pressure straight triple-effect for the evaporation of caustic liquors to a strength of 50° B. (sp. gr. 1.515) is attended with economic and practical disadvantages, and better results can be obtained by the use of a compound or triplex condensing engine working in connection with a double-effect, or a combination of a low-pressure triple-effect and a single-effect evaporator with a cast-iron heating surface. Figures are given to show that for a yearly production of 3600 tons of sodium hydroxide the cost of fuel alone is about £100 more with a high pressure triple-effect than with the alternative systems mentioned. For small plants producing up to 5 tons of sodium hydroxide per day, a single or double-effect evaporator should generally be used on account of low first cost and simplicity of operation.—W. E. F. P.

*Copper electrode; The reproducibility of the* —. F. H. Getman. Trans. Amer. Electrochem. Soc., 1914, 26, 67—78.

THE electrodes used in the investigation were:—electrolytic copper wires, 3 mm. and 1 mm. in diameter; platinum plates covered with a uniform and adherent electrolytic deposit of copper; electrolytic copper wires, 1 mm. in diameter, embedded in copper powder (Kahlbaum's "reduziert"); and fine platinum loops covered with a deposit of spongy copper obtained by electrolyzing a neutral solution of copper sulphate at high current density. The last was found to be the only constant and reproducible form, the values obtained with it being in close agreement with the theoretical requirements. The irregularities observed with the remaining forms are ascribed to a metastable condition of copper, the spongy variety being regarded as the stable modification under ordinary laboratory conditions.—W. E. F. P.

*Silicidised carbon. Silfrax.* Tone. See VII.

*Electrolytic insulation of aluminium wire.* Skinner and Chubb. See X.

*Electrometric titrations.* Ziegel. See XXIII.

## PATENTS.

*Electric [resistance] furnace. Process of making [nitrogen] compounds in electric furnaces.* S. Peacock, Chicago, Assignor to International Agricultural Corporation, New York. U.S. Pats. (A) 1,129,512 and (B) 1,129,513, Feb. 23, 1915. Dates of appl., Sept. 20 and 22, 1913.

(A.) THE furnace consists of a vertical rectangular shaft with two horizontal electrodes placed opposite one another, the cross-section of each being the same as that of the shaft. The whole is enclosed in a gas-tight metal casing. The charge is supplied from above by hand or from a valved hopper and the solid product is removed below by a conveyor. Nitrogen is introduced by two opposite valved pipes below the electrodes and the gaseous products are removed by similar pipes above. (B.) The reacting materials are heated in nitrogen in an electrical resistance furnace (see above). The supply of material and of nitrogen and the removal of the gaseous products and solid residue are continuous. The temperature of the reaction zone between the electrodes is regulated by the proportion of carbon in the mixture, the rate of passage through the zone, and the amperage of the current supplied. The voltage used is too low to allow of substantial arcing.—W. H. H. N.

*Electrode; Negative —, and process of making the same.* W. Tassin. Washington, D.C. U.S. Pat. 1,129,818, Feb. 23, 1915. Date of appl., June 6, 1914.

COPPER oxide is maintained at about its fusing point, until an intimate mechanically-inseparable mixture of cuprous and cupric oxides is obtained, in about the molecular ratio 2 : 1. This is moulded into any desired form.—B. N.

*Nickel oxide plates [for secondary batteries]; Preparation of —.* P. Hoyer. Ger. Pat. 277,743, July 17, 1913.

A GRANULAR mass of nickel, obtained, for example, by igniting nickel carbonate in a reducing atmosphere, is moistened and applied to a support of perforated sheet nickel or nickel wire gauze. After drying, the plate is heated to redness in a reducing atmosphere, then used as anode in the electrolysis of a solution of sodium or potassium carbonate, and the nickel subsequently oxidised electrolytically in a concentrated solution of potassium or sodium hydroxide.—A. S.

*Electrodes; Manufacture of —.* Schott und Gen. Ger. Pat. 279,253, July 22, 1913. Addition to Ger. Pat. 268,061 (see Eng. Pat. 17,759 of 1913; this J., 1913, 950).

THE metallic conductor passes through the carbon electrodes, and the parts near the electrode are thickened and enclosed in hot plastic glass, so that on cooling, the two glass portions press against opposite ends of the electrode.—A. S.

*Electric arcs; Process for obtaining rotating — by means of rotating gas currents.* A. Foss. Ger. Pat. 279,461, Sept. 16, 1913.

AN arc, struck, for instance, between annular electrodes, is caused to rotate in the known manner by introducing a current of gas tangentially into the furnace, and at the same time a current of gas is blown, preferably through an annular inlet, into the space enclosed by the arc and in the direction of the axis around which it is rotating. This current of gas tends to force the arc radially outwards, causing it to take the form of a rotating tube.—A. S.

*Electrodes in arc furnaces; Method and apparatus for protecting the —.* J. I. Bronn and W. Schemmann, Assignors to Rombacher Hüttenwerke, Rombach, Germany. U.S. Pat. 1,129,377, Feb. 23, 1915. Date of appl., Dec. 16, 1913.

SEE Eng. Pat. 29,259 of 1913; this J., 1914, 555.

*Electrolyte for alkaline dry cells.* E. Achenbach. Fr. Pat. 472,359, May 19, 1914. Under Int. Conv., May 21, 1913.

SEE Eng. Pat. 10,616 of 1914; this J., 1914, 871.

*Electrolysis of alkali chloride solutions, using a mercury cathode and a porous diaphragm.* Ger. Pat. 279,998. See VII.

*Process of introducing iron into foods, drugs, and beverages. Process of forming compounds of iron and carbohydrates.* U.S. Pat. 1,129,306 and 1,129,307. See XIXa.

## XII.—FATS; OILS; WAXES.

*Copra, coconut oil, and coconut cake; The industrial position of —.* Bull. Imp. Inst., 1914, 12, 557—577.

LARGE quantities of copra hitherto exported to Germany and Austria-Hungary are now available

for use elsewhere. Prior to the war a large proportion of the exports of copra from British possessions went to Germany, e.g., three-quarters of the total from Ceylon in 1913, and four-fifths of the total from India in 1912-13. The imports of copra from all sources to Hamburg (representing probably nearly the total German imports) were 230,395 metric tons in 1913, of which 124,434 metric tons came from British possessions. The Austro-Hungarian imports of copra in 1913 were 33,604 metric tons from all sources, including 29,177 metric tons from British possessions. A new market has thus to be found for nearly 154,000 metric tons of copra from British territories. Considerably more than half of this might be taken by the United Kingdom for home use, since in 1913, the British imports of coconut oil from foreign sources amounted to about 49,000 metric tons, corresponding to about 82,000 tons of copra. English firms engaged in crushing copra are extending their plant and there is a good prospect of the British market for copra being greatly enlarged. In addition the export trade in copra and coconut oil to Denmark, Scandinavia, and Russia is capable of development, and British Colonies and India should secure a share of the French import trade in copra; in 1913 France imported 72,964 metric tons from the Philippines and 43,422 metric tons from the Dutch East Indies. Coconut cake forms an excellent feeding stuff for milch cows and for fattening cattle, and the meal may be used to replace oats in the ration for horses. Coconut cake is nearly equal in food value to decorticated cottonseed cake, and somewhat superior to linseed cake, the low proportion of protein being compensated by high contents of carbohydrates and crude fibre. It is cheaper than linseed or cottonseed cake at the prices prevailing recently, when comparison is made on a basis of net cost per food unit, with allowance for the manurial value of the residues. Coconut cake produced in the United Kingdom is superior to that produced in Germany owing chiefly to the lower content of fibre and higher content of carbohydrates. (See also this J., 1914, 1096.)—A. S.

*Fat of Pentadesma Kerstingii.* H. Wagner, J. Muesmann, and J. B. Lampart. Z. Unters. Nahr. Genussm., 1914, 28, 241—249. Z. angew. Chem., 1914, 27, Ref., 700.

THE seeds of *Pentadesma Kerstingii*, when extracted with ether, yield 41.5% of a fat similar in appearance to butter fat but somewhat harder. The characters of the fat are: m. pt. 38—39° C.; solidif. pt. 29.2° C.; refractometer reading, 45—46 at 40° C.; acid value, 12.4; Reichert-Meissl value, 0.22; Polenske value, 0.4; saponif. value, 192; iodine value, 45.9; unsaponifiable matter soluble in ether, 0.6%. The fat gives no reaction with the reagents of Baudouin, Soltsien, and Halphen; with Bellier's reagent it gives a blue-violet coloration changing soon to wine-red.—A. S.

*Lipase of soya beans. Studies on enzyme action.* XIII. K. G. Falk. J. Amer. Chem. Soc., 1915, 37, 619—653.

A COMPARISON of the lipolytic properties of soya beans, castor beans, and duodenal contents, showed that the hydrolytic enzymes present had the following relations:—Soya beans contain a lipase active towards triacetin (and therefore presumably towards fats), slightly soluble in water, and with a maximum solubility in 1.5N sodium chloride solution. Castor beans contain an esterase soluble in water, and a lipase insoluble in water and soluble in sodium chloride solution. Duodenal contents contain an esterase and a lipase, the former predominating in the intestinal juice and

the latter in the pancreatic juice and bile. Marked similarities are shown by the lipases from different sources in their behaviour towards neutral salts and alcohols. When dried over calcium chloride or phosphorus pentoxide, soya bean lipase does not decrease in activity, but when dried at 100° C., the activity is reduced 50%; castor bean lipase and esterase are affected similarly by drying and heating. (See also this J., 1912, 593; 1913, 384.)  
—W. P. S.

*Palm-kernel cake and meal.* See XIXa.

*Use of nickel and its oxides in catalysis.* Senderens and Aboulenc. See XX.

#### PATENTS.

*Oleaginous substances; Means and apparatus for treating— and for melting and extracting fat and other products therefrom.* W. T. Powling, jun., and B. B. Powling, Prittlewell. Eng. Pat. 3661, Feb. 12, 1914.

Hot vapours escaping from material being reduced by dry heat (see Eng. Pat. 8397 of 1912; this J., 1913, 543) are utilised in the preliminary heating of fresh quantities of material, the vapours being thereby cooled and steam condensed.—C. A. M.

*Oils; Method of and apparatus for deodorising —.* J. T. Bateman, London. Eng. Pat. 24,605, Jan. 6, 1914.

THE exhaust superheated steam from the deodorising apparatus is used for the preliminary heating of a fresh quantity of oil, the aldehydes in the steam being subsequently condensed and separated. In a form of apparatus claimed, the steam heats the tubes of two heaters through which the oil passes.  
—C. A. M.

*Catalytic processes. [Hydrogenation of oils.]* O. C. Hagemann and C. Baskerville, New York. Eng. Pat. 3344, Feb. 9, 1914. Under Int. Conv., Feb. 8, 1913.

SEE U.S. Pat. 1,083,930 and Fr. Pat. 469,172 of 1914; this J., 1914, 207; 1915, 39.

*Catalysts [for hydrogenating oils]; Preparation of —.* W. Fuchs. Fr. Pat. 472,377, Aug. 1, 1913.

SEE Eng. Pat. 11,542 of 1913; this J., 1914, 702.

### XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS.

#### PATENTS.

*Elastic masses; Production of solid —.* W. Meusel. Ger. Pat. 276,363, June 25, 1913.

THE colloidal solid product obtained from linseed oil according to Ger. Pat. 201,906 or 258,900 (this J., 1913, 616) is mixed in suitable proportions with the product obtained from castor oil (*loc. cit.*), and the mixture, with or without other additions, is dried.—A. S.

*Lead paste from red or orange lead; Manufacture of —.* W. Eckford, Rhyl, Wales. U.S. Pat. 1,128,961, Feb. 16, 1915. Date of appl., April 9, 1910.

SEE Eng. Pat. 8017 of 1910; this J., 1910, 1398.

*White lead; Manufacture of —.* E. Euston. Fr. Pat. 471,348, April 25, 1914. Under Int. Conv., April 28, 1913.

SEE U.S. Pat. 1,075,143 of 1913; this J., 1913, 1077.

*Varnishes; Manufacture of submarine —.* G. Paterno and C. Manuelli, Milan, Italy. Eng. Pat. 29,524, Dec. 22, 1913.

SEE Fr. Pat. 466,368 of 1913; this J., 1914, 604. Reference is directed, in pursuance of Sect. 8, Sub-sect. 2, of the Patents and Designs Act, 1907, to Eng. Pat. 5432 of 1914.

*Chlorinating [oleaginous material to obtain artificial resins]; Process of —.* M. Buchner, Assignor to C. F. Boehringer und Soehne, Mannheim-Waldhof, Germany. U.S. Pat. 1,129,165, Feb. 23, 1915. Date of appl., Nov. 13, 1911.

SEE Ger. Pats. 256,856 of 1910 and 258,156 of 1911; this J., 1913, 499, 613.

### XIV.—INDIA-RUBBER; GUTTA-PERCHA.

*Caoutchouc-benzene-alcohol and caoutchouc-benzene-acetone; The systems —.* The behaviour of colloids towards pure and mixed liquids. Part I. W. A. Caspari. Chem. Soc. Trans., 1915, 107, 162—171.

THE caoutchouc employed in the experiments was a de-resinified pale plantation crêpe. The solvents were carefully dried. Caoutchouc changes from the gel to the sol condition reversibly, and it is therefore possible to represent the system, caoutchouc-solvent-precipitant, by isothermals which express all possible equilibria between the three substances concerned. The physical stability of the solutions employed was sufficient not to have any important influence upon the results. (1) Fresh solutions of caoutchouc in benzene, of known concentration, were titrated with alcohol until separation into two phases just set in. The limiting triads thus obtained were plotted on a binodal curve. Volume percentages were calculated by taking 0.91 as the sp. gr. of the caoutchouc, and neglecting volume changes. (2) Excess of alcohol was added to benzene solutions of caoutchouc. Two fluid layers were formed in equilibrium and the composition of each represented a point on the binodal. Tie-lines representing distribution of benzene between caoutchouc and alcohol were also obtained by this method. Caoutchouc was determined in the upper layer by evaporation, and the ratio of benzene to alcohol by determination of refractivity and comparison with an experimental curve. The volume of the lower layer was measured, and its composition calculated from these data. (2a) When the precipitated clot contained too much caoutchouc to form a homogeneous layer, it was removed, pressed between filter-paper, and its volume measured in a volumometer charged with a benzene-alcohol mixture. Under these circumstances the upper layer was free from caoutchouc. It was found that in presence of water far less precipitant was required to produce precipitation. In the case of the system including acetone, method (2) could not be employed, owing to flocculation in the lower layer. The following conclusions are drawn from a discussion of the results. Caoutchouc is practically insoluble (at 20° C.) in mixtures containing 43 vols. or more of absolute alcohol or 80 vols. or more of anhydrous acetone to 100 of benzene. Presence of water in the precipitant results in economy of the latter. A very small excess of precipitant serves in general to precipitate the whole of the dissolved caoutchouc; hence the latter cannot be separated into components by fractional precipitation. For caoutchouc concentrations greater than 2% in the

original benzene solution, quantitative relations are given roughly by the equation for the binodal of caoutchouc-benzene-alcohol at 20° C.:

$$\left(\frac{100 C}{B}\right)^{0.24} \times \left(\frac{100 A}{B}\right) = 60$$

A, B, C, being volumes of alcohol, benzene, and caoutchouc respectively. There are indications from the experimental results that discontinuity between caoutchouc-benzene sol and caoutchouc-benzene gel exists in the neighbourhood of 1 vol. caoutchouc: 6 vols. benzene. It is significant that the caoutchouc employed absorbed about 6 vols. of benzene before passing into solution. —E. W. L.

#### PATENTS.

*Rubber latex; Coagulation of* — N. W. Barritt, Shrewsbury. Eng. Pat. 3632, Feb. 12, 1914.

RUBBER latex is concentrated to a definite degree by evaporation under reduced pressure at ordinary temperatures—say not exceeding 50° C.—and is then coagulated by exposing it, in a thin film, to acetic acid vapour or to smoke. —E. W. L.

*India-rubber, caoutchouc, and other similar material; Apparatus for washing and cleaning* — W. G. Gass, Bolton. Eng. Pat. 1200, Jan. 16, 1914.

THE apparatus, which is designed primarily for the treatment of scrap or bark, etc., comprises a casing containing a main inclined roller grooved longitudinally, and one or more plain rollers frictionally driven from the main roller through the material being treated; or one of the plain rollers may be positively driven. The lower part of the casing is provided with longitudinal pressure surfaces, or ridges, alternating with longitudinal grooves or pockets, the ridges being almost in contact with the tops of the teeth on the grooved roller. The casing is provided with inclined guides to carry the material from the lower, feed end of the rollers to the upper, discharge end, where knives attached to the main roller cut it into short lengths. The material is fed into the machine from a hopper provided with a revolving barrel having blades co-acting with a stationary blade or other arrangement for the purpose of cutting up the material into small pieces before it enters the machine. Water enters the casing of the machine near the upper discharge end of the inclined rollers, and passes out through an overflow at the other end, carrying with it the sand and dirt, which fall away at the lowest point of the feed end. The machine may be heated, and the casing and cover may be easily removed for purposes of cleaning, inspection, and the removal of the washed product, where, as in the case of very soft rubbers, it is not desirable to work the machine automatically. —E. W. L.

*Rubber; Machines for preparing* — J. E. Pointon, Peterborough. Eng. Pat. 4105, Feb. 17, 1914.

THE machines contain screw-like or spiral rotating blades having their forward surfaces of convex or like form so as to knead the material by pressure against the walls of the chamber. The blades may have radial or concave tips and be of equal or unequal radial length. —C. A. M.

*Caoutchouc or caoutchouc-like substances; Process for accelerating the vulcanisation of natural or artificial* — S. J. Peachey, Stockport. Eng. Pat. 4263, Feb. 19, 1914.

VULCANISATION is accelerated by the addition to the mixing of small quantities of *p*-nitrosodimethylaniline or of its homologues such as *p*-nitrosoethylaniline or *p*-nitrosoethylaniline. For example, a mixing composed of plantation rubber, 100; sulphur, 10; and accelerator 0.5 parts

can be vulcanised in 20 minutes at 135°–145° C., as against one hour without the accelerator. A hard and durable ebonite is obtained by heating for 2 hours at 145° C. a mixing composed of plantation rubber, 100; sulphur, 40; accelerator, 0.75 to 1.0 parts; without accelerator the time of vulcanisation is about 6 hours. —E. W. L.

#### XV.—LEATHER; BONE; HORN; GLUE.

*Tanning materials; Analysis of* — intended especially for tanning fishing nets. G. C. A. van Dorp, Collegium (London), 1915, 71–72.

MATERIALS showing a higher tannin value than cutch when tested by the hide powder method, are not always so suitable for tanning fishing nets. The author proposes a method of analysis giving better results, which depends on the adsorption of the material by cotton. As a standard, the adsorption of cutch under definite conditions is first determined by shaking a solution of known strength with cotton and subsequently evaporating the residual solution. An adsorption curve for cutch solutions of different concentrations is constructed, and the strength of a solution of any other material giving a certain adsorption compared with the strength of a cutch solution giving the same adsorption, shows the value of the material. —F. C. T.

*Bates; Artificial* — J. T. Wood, Collegium (London), 1915, 82–85.

Two new proprietary articles are discussed, which the manufacturers describe as bates. The vendors of one ("Pilos") state that it destroys fats and greases in the skin, but investigation showed it to contain about 80% of ammonium chloride and failed to show either lipolytic or tryptic enzymes. A practical test did not substantiate the claims made for it. The other article, "Enzo," described as a substitute for natural bate or puer, contained 68.7% ammonium chloride, 8.4% gelatin and proteins, and 15% starch; diastase was present but not tryptic enzymes. It is thus a deliming material combined with a drenching material, and capable of useful service, though not as a bate. An artificial bate should be composed of an ammonium compound and a tryptic enzyme combined with some inert carrier such as kaolin or wood dust. No artificial bate can have all the properties of puer, owing to the presence in the latter of certain compounds in very minute quantities which have some specific effect on the bating action. —F. C. T.

*Neradol D; Experiments with* — (1) A. Rogers, and (2) G. J. Laemmle, H. J. Newman, and N. W. Shepard, Tanners' Inst., Brooklyn. Reports of Third Year, 25–30, 38–42. J. Amer. Leather Chem. Assoc., 1915, 10, 105–106.

THE influence of Neradol D in hastening vegetable tannage and on the final yield of leather was investigated. In the case of hide and sheep skin a preliminary treatment with Neradol D rendered subsequent vegetable tannage more rapid at first, but did not influence the final yield of leather. Calf skin, pickled as for chrome tannage, gave a similar yield with a combination of Neradol D and quebracho as with quebracho alone; Neradol D alone did not give so good a yield of leather. —F. C. T.

*Tannage; [Determination of] degree of* — W. James, Collegium (London) 1915, 76–77.

THE organic insoluble matter of leather, apart from hide substance, may contain matter such as

"bloom" which is fairly easily washed out and cannot be regarded as combined tannin. The author proposes, in the determination of water-soluble matter, to evaporate the unfiltered aqueous extract and thus include "bloom," etc., in the water-soluble matter and not in the combined tannin.—F. C. T.

#### PATENTS.

*Leather-board; Method of making* —. A. L. Clapp, Braintree, Mass., Assignor to Hide-Itc Leather Co., Boston, Mass. U.S. Pat. 1,128,290, Feb. 16, 1915. Date of appl., Jan. 11, 1913.

LEATHER scrap or fibre is washed and mixed with a waterproofing material capable of depositing an insoluble precipitate on the fibres by a reaction with tannic acid, and the wash water which contains tannic acid is then added to the mixture. The wash water may be treated with alum and heated before addition to the mixture.—E. W. L.

*Gelatin masses; Production of transparent objects from* —. L. Trommer. Ger. Pat. 278,667, April 27, 1913.

AN aqueous solution of 100 parts of gelatin, 1—3 of potassium bichromate, 2—4 of magnesium sulphate, 2—4 of potassium sulphate, 3—4 of borax, and 3—4 parts of sodium chloride, with or without addition of colouring matters, is concentrated on the water-bath and poured into moulds. The moulded objects, after cooling, are treated with hardening agents or coated with a lacquer.—A. S.

*Leather, artificial; Process for colouring* —. E. Girzik. Fr. Pat. 472,023, May 9, 1914. Under Int. Conv., Dec. 18, 1913.

SEE Eng. Pat. 4668 of 1914; this J., 1911, 539.

### XVI.—SOILS; FERTILISERS.

*Flue dust [from iron works] as manure*. J. Board Agric., 1915, 21, 1043—1046.

A SAMPLE of flue dust from an iron works in the Midlands was found by the Government Laboratory to contain nearly 6%  $K_2O$ , about one-third of which was directly soluble in water, together with about 7%  $CaO$  as gypsum. No substance directly harmful to plant life was present, and the proportion of water-soluble magnesia was only 0.29%. It is doubtful whether the potash could be extracted profitably, but the material could be used locally as a manure.—J. P. O.

#### PATENTS.

*Phosphate rock; Process of treating natural* —. F. K. Hoover and A. J. Mason, Chicago, Ill. U.S. Pat. 1,128,874, Feb. 16, 1915. Date of appl., June 9, 1911.

THE crude phosphate rock is triturated with water to form a plastic mass, a further quantity of water is added, and the mixture is subjected to currents of water, so as to separate the clean phosphate mineral by gravity.—F. SODN.

*Phosphate rock; Process of treating pebble* —. W. F. Lay, Boston, Mass. U.S. Pat. 1,129,407, Feb. 23, 1915. Date of appl., May 1, 1914.

THE pebbles, previously separated from the matrix, are immersed in an acidulated bath, which is preferably heated and agitated, so as to separate and neutralise adherent alkaline matter, and the

liquor is then drawn off and fortified with additional acid for treating a further supply of pebbles, whilst the treated pebbles are washed with water.—F. SODN.

*Guano or the like; Process for simultaneously colouring — and treating it with acid*. Chem. Fabr. vorm. Weiler-ter-Meer. Ger. Pat. 280,227, July 25, 1913.

THE guano is treated with sulphuric acid in which a soluble organic dyestuff has been dissolved. Suitable dyestuffs are Auronal Orange, Brown, and Yellow, Bismarck Brown, and Toluylene Orange.—A. S.

*Production of mixtures for destroying plant pests*. Ger. Pat. 279,563. See XIXB.

### XVII.—SUGARS; STARCHES; GUMS.

*Cane stalk; Varying concentration of the juice in the cells of the* —. R. S. Norris. Intern. Sugar J., 1915, 17, 127—128.

CANES of the Lahaina and Yellow Caledonia varieties were cut into sections, and the nodes and internodes, and in some cases also the pith and rind, submitted separately to successive pressings. In each instance the juice was found to increase considerably in density with each successive pressing; in one case, using very heavy pressure, the juice extracted by the last operation had a density more than twice that of the first expressed juice. It is concluded that in different parts of the cane there are a few cells containing juice of high density and having walls more resistant to crushing than those containing weaker juice. In another experiment the cane was passed through a Jeffry pulveriser, and the parenchyma and fibro-vascular cells were then separated by shaking with the hand. In this case successive pressings produced no increase in the density of the several juices obtained, the explanation advanced being that the cells containing juice of high density were ruptured with the others during the process of shredding. The results indicate that there is an advantage in the practical milling of cane in reducing it to a fine state of division, either by shredding or by the grinding action of the rollers in the early part of the process, so that none of the juice of high density is retained in the final bagasse.—J. P. O.

*Beets; Determination of sucrose in frozen and thawed* — [by the double polarisation method, using acid and invertase as hydrolysts.] E. Saillard. Circ. hebdom. Synd. Fabr. Sucre de France, 1915, 27, Nos. 1350, 1351, and 1352.

IN the determination of sucrose in roots which had been frozen and thawed, there was an appreciable discrepancy between the figure given by the ordinary double polarisation (Clerget) method and that deduced from the determination of the reducing sugars before and after inversion by hydrochloric acid. This result pointed to the presence of non-sugar substances in the deteriorated roots, the optical activity or cupric-reducing power of which was modified by the action of the hydrochloric acid used for hydrolysis so as to vitiate the sucrose value. When invertase was used as hydrolyst in place of hydrochloric acid, the solution being clarified as described by Ogilvie (this J., 1911, 62), the two methods of determining the sucrose gave concordant results.—J. P. O.



*Sugar: Norit process of manufacturing white —.*

A. Wijnberg. Intern. Sugar J., 1915, 17, 70—74 and 129—131. (See Eng. Pats. 21,204 of 1911 and 11,860 of 1912; this J., 1912, 1047; 1913, 376.)

"NORIT" is a special decolorising carbon for use in the sugar industry as a substitute for animal charcoal. The quantity of colour that can be removed by the carbon from a solution of cane molasses depends principally upon the concentration of the colouring matter; the point at which the carbon cannot adsorb any more colouring matter varies very considerably according to the kind of carbon and the nature of the colouring matter. Though in some cases relatively little carbon may be required to remove most of the colour from a solution, a large amount is necessary to eliminate the last traces; in one experiment, for example, twice as much carbon was required to remove the last 10% of colour as was needed to remove the first 90%. In tests in which the colour was only partly removed, the decolorising power of "Norit" carbon was about 25 times greater than that of animal charcoal. Since the presence of sugar and salts has a marked inhibiting effect on the action of the carbon, the thin-juice and not the thick-juice must be operated upon in practice, in order to obtain the most profitable decolorisation. In alkaline and neutral media little or no adsorption of the colouring matter may take place, whereas decolorisation is readily effected in a solution having an acidity corresponding to about N/100. By boiling the spent carbon with a 3% solution of sodium hydroxide or carbonate for about 15 minutes and washing, the material is revived to a large extent (see Eng. Pats. 19,357 of 1912 and 17,432 of 1913; this J., 1913, 85; 1914, 853); e.g., if originally its decolorising power was 92%, after the regenerating treatment it may be 87%, becoming constant at 65% after being regenerated about 10 times. The carbon adsorbs gums and pectins in addition to colouring matter: a solution of cane molasses after treatment passed readily through filter-paper, whereas previously it percolated with difficulty.

*Experiments on the large scale.* In a factory in Natal the mill juice was sulphited, limed to a slightly acid reaction, boiled, treated with about 0.5% of the decolorising carbon, and passed through filter-presses; the clear liquid was almost colourless. After evaporation, the resulting syrup was filtered through Perrin filters without the difficulty that is often experienced owing to the presence of gummy matters, and this favourable effect was further noticed during the operations of vacuum pan boiling and centrifuging. The sugar finally obtained was sold at prices corresponding to those obtained by the refined sugar made at refineries. The spent carbon was regenerated by boiling with a 5% solution of sodium carbonate and washing; its decolorising action was not diminished considerably thereby. Trials were also made in a Greenock refinery, where it is stated that the entire usual Taylor filter installation was discarded, though the existing charcoal installation was still retained. After affining the raw sugar in centrifugals in the ordinary way, it was dissolved to a liquor of 60° to 65° Brix, slightly acidified, treated with 1% of the carbon, and passed directly through a filter-press. Filtration proceeded very rapidly, notwithstanding the comparatively high concentration of the liquor, and the cakes were easily washed and well exhausted. Even after regenerating the carbon 30 times, its value decreased only to 70% of what it was originally. It is claimed that the use of the decolorising carbon opens up the possibility of making refined sugar directly from juice, and of carrying on refining operations in some factories all the year round.—J. P. O.

*Reducing sugars; Studies on the decomposition of — with reference to white sugar manufacture.*

A. Schweizer and G. Loos. Archief Suikerind. Nederl.-Indië, 1914, 22, 1855—1859. Intern. Sugar J., 1915, 17, 141.

FRAMM (Pflüger's Arch. Physiol., 64, 573) has shown that the presence of air has a considerable influence upon the decomposition of reducing sugars by alkalis. To determine the effect of air in the carbonatation process of making high-grade sugars, a sucrose solution containing reducing sugars was treated with 3% of milk of lime at 20° B. (sp. gr. 1.157), and maintained at 28° C. for 3 hours, whilst a second solution was treated similarly, except that a slow current of air was passed through it for 3 hours. Both liquids were carbonated to a slight alkalinity, heated to 55° C., and filtered. It was found that decomposition of reducing sugars had taken place in both cases, but in that in which air had been used the colour was distinctly less.—J. P. O.

*Scums [produced during beet sugar manufacture]; Sucrose content of —.*

H. Pellet. Intern. Sugar J., 1915, 17, 132—133.

THE scums formed during carbonatation may contain at the same time insoluble sucrose in the form of saccharate and insoluble sucrose which has been carried down by the bulky precipitate produced on the addition of lime to the dense diffusion juice. Carbon dioxide acts more or less on both forms, making the quantity of insoluble sucrose found in the press-cake very variable, depending upon the conditions of working. When the insoluble sucrose is mostly present in the form of saccharate, greater difficulty is experienced during the process of washing than when it has been carried down mechanically.

—J. P. O.

*Alkali sulphites [in the sugar industry]; Catalysis in the oxidation of —.*

E. Saillard. Compt. rend., 1915, 160, 318—320.

IN the treatment of syrups and sugar juices with the gases of a special sulphur-burner, containing 10—14% SO<sub>2</sub>, the following were found to act as catalysts in the oxidation of alkali sulphite to sulphate: *Retarding agents:* sucrose, invert sugar, non-sugars, ammonium oxalate, glycerin, free and carbonated alkalis, asparagine, glutamic acid, and potassium lactate. *Accelerating agents:* (in the form of fine powder) nickel, zinc, aluminium, ferric oxide, manganous oxide, calcium carbonate, marble, magnesium carbonate, fire-brick, calcium sulphate, calcium phosphate, calcium oxalate, alumina, and calcium sulphite. The rate of oxidation increases regularly with rise of temperature between 15° and 90° C., and decreases rapidly with the sugar concentration up to a content of about 60% of sugar. *Practical conclusions:* Oxidation of alkali sulphite is very difficult in molasses, which contains about 50% of sugar and 33% of non-sugar, and is retarded by the maintenance of low temperatures and the absence of precipitable lime, which might give rise to the formation of calcium carbonate or sulphite.—O. R.

*Notes on [use of] caramel [in brewing].*

See XVIII.

## PATENTS.

*Sweetmeats and the like; Manufacture of —.*

E. Shaw, London. Eng. Pat. 3824, Feb. 13, 1914. A SOLUTION of sugar which has been inverted by means of an acid and then neutralised, is mixed with sugar containing sodium bisulphite and the mixture quickly boiled.—J. F. B.

*Sugar; Recovery of—* from molasses, especially cane molasses. F. Tiemann. Ger. Pats. (A) 279,719 and (B) 279,720, Dec. 24, 1912, and July 5, 1913.

THE methods are based on the known fact that invert sugar is capable of displacing sucrose from impure solutions. (A) Desaccharification is effected by adding to the molasses invert sugar separated by known methods from a separate portion of the same molasses. (B) The molasses is treated with strong acids or acid salts added in such quantities that a portion of the dissolved sucrose is inverted and the treated juice contains sucrose, invert sugar, and salts in the relative proportions most favourable to the recovery of the sucrose by crystallisation.—A. S.

*Sugar in fine crystals; Manufacture of—*. J. F. P. Kestner. Fr. Pat. 471,912, July 22, 1913. SEE Eng. Pat. 17,010 of 1914; this J., 1915, 241.

*Automatic charging and discharging device for vacuum dryers.* Ger. Pat. 280,035. See I.

*Process of introducing iron into foods, drugs, and beverages. Process of forming compounds of iron and carbohydrates.* U.S. Pats. 1,129,306 and 1,129,307. See XIXA.

## XVIII.—FERMENTATION INDUSTRIES.

*Diascise; Determination of the activity of—*. O. Wolff. Chem.-Zeit., 1915, 39, 103—107.

FOR the study of enzyme reactions, e.g., the determination of diastatic activity, the Zeiss interferometer (this J., 1911, 770; 1912, 559) is far more sensitive than the refractometer. In the 2 cm. cell a 0.2% solution of soluble starch shows a reading of 142 as compared with water, while a similar solution of dextrose shows 200, the subjective error of the instrument being only 2 scale divisions. The interferometer may be calibrated by means of 1% solutions of soluble starch and dextrose, one cell being kept filled with the starch solution and compared with mixtures of starch and dextrose in complementary proportions in the other cell. The differential readings are plotted with scale divisions as abscissæ and grms. of dextrose as ordinates, and a straight line is thus obtained from which subsequent results can be integrated, provided identical quantities of water or solid matters be added to each solution. For the estimation of diastatic activity, a known quantity of diastase is added to each of two 50 c.c. portions of 1% starch solution in two flasks; one portion is immediately boiled to destroy the enzyme and the other is digested at 38° C. for 2 hours. Both solutions are filtered through dry paper filters of the same size and the clear filtrates compared together in the cells of the interferometer. Some little difficulty may arise in obtaining perfectly clear filtrates and hence it is seldom possible to employ the 4 cm. cells, but if very small proportions of enzyme are present, the delicacy of the method may be increased by adopting a longer time of digestion. Determinations have shown that the readings obtained are proportional to the quantity of diastase within certain limits.—J. F. B.

*Malt amylase; Purification of—*. H. C. Sherman and M. D. Schlesinger. J. Amer. Chem. Soc., 1915, 37, 643—648.

MALT amylase loses activity during its separation by dialysis, apparently owing to hydrolytic destruction of the enzyme. \*When the dialysis is

carried out at a low temperature, the loss is greatly diminished, and the following method is recommended. Concentrated malt extract is placed in a collodion sack which is suspended in a large volume of water at 5° to 10° C. for 24 hours, the water being changed two or three times during this period. The clear solution is then decanted from the sack and ammonium sulphate is added in the proportion of 45 grms. for every 100 c.c. of solution. The mixture is kept below 10° C. until the salt has dissolved, the clear liquid portion is then decanted and rejected, and the precipitate dissolved in cold water. This solution is again dialysed as before for 24 hours, and the solution mixed with an equal volume of cold 99.8% alcohol. The precipitate is separated, the solution mixed with a quantity of alcohol sufficient to make the alcohol content 65% (by vol.), and the precipitate is collected and dried over sulphuric acid under reduced pressure in the dark and at a temperature not above 15° C. In this way the authors have obtained preparations having a diastatic power of 1200 to 2350 on Lintner's scale.—W. P. S.

*Malt amylase; Influence of certain acids and salts upon the activity of—*. H. C. Sherman and A. W. Thomas. J. Amer. Chem. Soc., 1915, 37, 623—643.

THE activity of pure malt amylase was increased by acetic, propionic, phosphoric, hydrochloric, nitric, and sulphuric acids, and by the chlorides, nitrates, sulphates, and primary phosphates of sodium and potassium (see this J., 1913, 986). The activities observed at the optimum concentrations of these different electrolytes varied from less than double to more than thirty times the corresponding activities in the absence of the electrolyte. Acids had a greater effect than neutral salts, but the acid phosphates of sodium and potassium were as effective as any of the free acids. The weak and strong acids and the acid phosphates all showed optimum activation at those concentrations which had essentially the same acidity; this optimum hydrogen ion concentration, as expressed by Sørensen's exponent, in each case lay between the limits  $p_H^+$  4.2 and 4.6. When the concentration of the acid exceeded the optimum, the activity of the enzyme was diminished; it was almost entirely destroyed in the presence of from five to eight times the optimum quantity of a strong acid. Whether the activating agent was an acid or a salt, the amylolytic action, as measured by the Wohlgemuth method (Biochem. Zeits., 1908, 9, 1), reached an optimum at a concentration of the activating agent much below that which gave an optimum saccharogenic action.—W. P. S.

*Malt and beer.* F. P. Siebel. Master Brewers' Assoc., U.S.A. Brewers' J., 1915, 51, 169—172.

DEALING more especially with the brewing of all-malt beers under American conditions, the author prescribes an evenly graded barley with plump corns, retained by a 2.5 mm. sieve, in order to avoid an undue proportion of husks. In malting, the strength of the peptic enzyme must be well developed, not so much from the point of view of its activity in the finished malt as from that of the modification it effects during germination. Slow growth is therefore necessary, at 15°—19° C. (59°—66° F.) for 6 or, preferably, 8 days. Under-germinated malts cannot be rectified in mashing, but if poor modification is the result of too rapid growth it can be remedied by the action of the peptic enzyme in the mashing. The acrospire should be three-quarters developed rather than full grown. The green malt should not be withered but dried on the upper kiln at 41°—43.5° C. (105°—110° F.) with full draught, treated on the lower kiln

feces, flies, and cheese, showed considerable variation when the cultures were heated in milk for 30 minutes under conditions similar to pasteurisation. At 60° C., 95 cultures survived; at 62·8° C., the usual temperature for pasteurising, 12 survived. One culture was not destroyed by heating to 65·6° C., until the heating was repeated. The survival of the few cultures at the higher temperature was due to the resistance of a few cells, and it is evident that 62·8° C. maintained for 30 minutes is a critical temperature for *B. coli*. The colon test as an index of the efficiency of the process of pasteurisation of milk, is complicated by the ability of certain strains to survive a temperature of 62·8° C. for 30 minutes and to develop rapidly when the pasteurised milk is kept under the conditions of temperature met with during storage and delivery. If, however, milk is pasteurised at 65·6° C. or above for 30 minutes, few *B. coli* would survive, and the colon test might be of value.

—W. P. S.

*Rice: The organic phosphorus of*—. A. R. Thompson. *J. Agric. Research*, 1915, 3, 425—430.

RICE bran was found to contain 8·22% of phytin, whilst polished rice was free from this substance. Analyses of barium phytate, prepared according to Anderson's method (this J., 1914, 371) from unpolished rice and rice bran, respectively, contained:—C, 6·51 to 6·97; H, 1·75 to 1·87; P, 16·05 to 16·43; Ba, 36·84 to 37·84%. Inositol was prepared from the barium phytate by hydrolysis with 30% sulphuric acid at 150° C. for 5 hours.—W. P. S.

*Palm kernel cake and meal: a new feeding stuff for live-stock*. Bull. Imp. Inst., 1914, 12, 577—579.

THE first consignment of palm kernels (1600 tons) from British West Africa to Hull was recently landed, and a very large proportion of W. African palm kernels will probably be crushed in Great Britain in future. There will be no difficulty in disposing of the oil, but palm-kernel cake, though a popular feeding stuff in Germany, Holland, Denmark, and Scandinavia, is comparatively unknown in Great Britain. British-made palm-kernel cake and meal are superior in quality to the German products, as is shown in the following table:—

	Palm-kernel cake (expressed).			Palm kernel meal (extracted).		
	English.			German.		
	1	2	3	German	English	German
Moisture.....	12·0	12·9	10·85	9·7	15·0	10·9
Crude protein	16·75	18·5	16·12	17·7	19·0	18·7
Fat .....	7·07	5·5	6·17	8·6	2·0	1·6
Carbohydrates.	48·83	50·0	48·51	36·2	51·0	39·1
Crude fibre ...	13·55	10·0	14·80	23·8	9·0	25·4
Ash .....	3·8	4·0	3·55	4·0	4·0	4·3
Food units ...	106	110	104	102	104	90

(See also this J., 1914, 1060, 1218.)—A. S.

*The industrial position of copra, coconut oil, and coconut cake*. See XII.

## PATENTS.

*Flour: Manufacture of an improved form of—and apparatus for use therein*. T. T. Vernon, Chester. Eng. Pat. 558, Jan. 8, 1914.

THE flour is delivered from a hopper in a fine stream on to an inclined plane where it receives drops of water at 130° F. (54° C.) delivered from points projecting through perforations in a trough. The drops of water are immediately surrounded with flour, and these aggregates passing on to a sieve are separated from the fine flour which is returned to the hopper. The aggregates pass on to a series of endless travelling bands in a casing through which a current of warm air (at 100°—140° F., 38°—60° C.) is drawn, then on to a second sieve and into a second casing, the lower portion of which acts as a cooler. From this, the aggregates drop on to a third sieve and thence into a sack. Suitable substances may be dissolved in the water used.—J. H. J.

*Flour or bread, or other foods made therefrom: Manufacture of*—. J. E. Shackleton, Pleasington, Lancs. Eng. Pat. 7383, March 24, 1914.

WHEAT from which flour is to be prepared is steeped in a liquid obtained by washing or steeping unwashed wheat in water, or the flour itself is sprayed with the liquid. The liquid, before use, is allowed to stand until it becomes acid, then concentrated and filtered.—W. P. S.

*Grain or the like: Appliances for heating, drying, and cooling*—. E. Samuelson, Banbury, and J. Backhouse, Bootle. Eng. Pat. 4589, Feb. 23, 1914.

A GRAIN heating chamber is enclosed within a casing, the air in which is heated by radiation or convection from the sides of the chamber or from hot water pipes. This heated air is drawn downwards through louvred columns, through which also the grain falls from the heating chamber above. Valves are provided for regulating the admission of fresh air to the casing and the columns. From the bottom of the columns the grain passes down over baffle-plates, between which a current of air at 60°—70° F. (16°—21° C.) is drawn, and finally between tubes containing a cooling fluid.—J. H. J.

*Kola preparation: Process for making a*—. G. C. Zimmermann, Stuttgart, Germany. Eng. Pat. 15,725, July 1, 1914. Under Int. Conv., July 2, 1913.

A KOLA preparation free from bitter flavour is obtained by disintegrating fresh kola nuts, allowing them with the juice to lie in vats until an odour of violets is produced, indicating that fermentation has commenced, and then roasting the mass. The product may be extracted with hot water and the extract mixed with sugar, or the extract may be used directly as a beverage.—W. P. S.

*Foods, drugs, and beverages: Process of introducing iron into*—. *Process of forming compounds of iron and carbohydrates*. H. L. Marsh, Philadelphia, Pa. U.S. Pats. (A) 1,129,306 and (B) 1,129,307, Feb. 23, 1915. Dates of appl., Dec. 5 and 26, 1914.

(A) A SOLUTION of a carbohydrate (sucrose) is heated under pressure to about 300° F. (149° C.) and subjected to electrolysis, an iron anode being used. (B) A current of electricity is passed through a solution of a carbohydrate, e.g., sucrose, contained in a cell divided into two communicating compartments; an iron anode is employed and both the anode and the cathode are suspended in their respective compartments at some distance from the dividing wall.—W. P. S.

[Extracts] having a vegetable base; *Manufacture of products*—H. Schmidt, Meudon, France. U.S. Pat. 1,128,628, Feb. 16, 1915. Date of appl., Dec. 26, 1911.

SEE Eng. Pat. 25,151 of 1911; this J., 1912, 947.

*Apparatus for impregnating liquids with carbonic acid or other gases.* Eng. Pat. 19,769. See I.

### XIXB.—WATER PURIFICATION; SANITATION.

*Soil-contaminated wounds; Elementary principles involved in the treatment of*—A. G. R. Foulerton. *Lancet*, 1915, 188, 484–490.

THE principal object in the treatment of soil-contaminated wounds is the avoidance of dangers arising from the entry of anaerobic soil bacteria or their spores, e.g. *B. oedematis maligni*, *B. welchii*, *B. perfringens*, etc. These organisms may be dealt with by disinfecting the wound by the use of germicides, or by inhibiting the activity of the organisms by continuous oxygenation, or by a combination of these two methods. The second method, used alone or following the first, prevents any danger arising from an anaerobic state of the tissues. Suitable oxidising agents are calcium and barium peroxides and sodium perborate. To ascertain the relative rapidity of the evolution of oxygen by these substances, equal weights were added to water, pus, and blood corpuscles in fermentation tubes and incubated at 37° C. The volume of oxygen given off was observed after 1 and 2 hours and 1 and 2 days. In all the experiments, the evolution of oxygen from the perborate was the most rapid and gave the largest volume of gas after 2 days. The rate was not constant, being very rapid during the first few hours and slowing down afterwards. The residues after decomposition were slightly alkaline; the perborate dissolved completely in pus and blood, but the peroxides left an insoluble residue. To show that the nascent oxygen evolved from these compounds was an active germicide, experiments were carried out with these substances added to bacterial emulsions, pus, and putrid meat. Pyogenic cocci were killed after 2 hrs. by 2.5% barium peroxide solution and after 1 hr. by 5% perborate; *B. coli* was killed in 15 mins. by 5% perborate, and anthrax spores in 1 and 2 days. The time required to sterilise the pus and the meat varied from 1 to 2 days. In practice, if the wound is fresh, application of perborate after cleaning the wound will maintain aerobic conditions, the nascent oxygen also acting as a germicide to aerobic organisms. If the wound is not so recent and there has been time for spores to germinate under the anaerobic conditions set up, then the wound should be cleaned and swabbed with pure phenol, before applying the perborate.—J. H. J.

*Sulphur in peptone [e.g. in culture media]; Comparative study of methods for the determination of*—H. W. Redfield and C. Huckle. *J. Amer. Chem. Soc.*, 1915, 37, 607–611.

Of various methods investigated, the Liebig-Koch process, in which the substance is treated with nitric acid and then fused with a mixture of potassium hydroxide and nitrate, was found to be the most trustworthy for the determination of total sulphur in peptone. The treatment with nitric acid need not be prolonged for more than 2 hours and there is no loss of volatile sulphur compounds during this part of the process. As regards methods for determining a part only of

the sulphur, the Schultz method for loosely-combined sulphur (see this J., 1902, 505) and the digestion process with nitric acid and potassium chlorate for readily oxidised sulphur, gave the most accurate results.—W. P. S.

*Sulphur in the culture medium for the detection of bacteria producing hydrogen sulphide; Determination of*—H. W. Redfield and C. Huckle. *J. Amer. Chem. Soc.*, 1915, 37, 612–623 (see also preceding abstract).

THE authors have made an investigation as regards the total amount of sulphur broken down by the so-called putrefactive bacteria, the forms of sulphur most readily used by the bacteria, and the forms in which the sulphur existed after their action. More material is broken down and more hydrogen sulphide is produced the larger the surface of medium exposed. When sterile air is passed over the cultures, about 50% more total sulphur is converted into hydrogen sulphide than when they are exposed to quiescent air, and about 100% more than when carbon dioxide is passed over them. From 25 to 30% of the total sulphur is converted into hydrogen sulphide when the cultures are incubated for 48 hours in a current of sterile air, and 50 to 60% when incubated for 72 hours. In media made from the portion of peptone soluble in alcohol, much less sulphur-containing substance is broken down and much less hydrogen sulphide produced than in the case of media made from the portion of peptone insoluble in alcohol. A larger percentage of sulphur-containing substance than of total peptone is broken down by the bacteria, the ratio being 3:1, and slightly more readily-oxidised sulphur than total sulphur is converted into hydrogen sulphide (4:3). Further, the loosely-combined sulphur is converted into hydrogen sulphide to a greater extent than is the total sulphur (3:2) but only slightly more so than the readily oxidised sulphur (10:9). The volumetric iodine method is not available for the determination of the hydrogen sulphide evolved owing to the presence of volatile unsaturated organic compounds; potassium hydroxide solution is to be preferred for absorbing the hydrogen sulphide.—W. P. S.

### PATENTS.

*Delivering powdered material into liquids; Apparatus for*—[Water softening.] C. R. B. Brown, London. Eng. Pat. 3662, Feb. 12, 1914.

THE powder rests on a piston which forms the bottom of a cylindrical vessel, open at the top and supported over a mixing tank. The spindle of the piston is raised by a ratchet wheel. The liquid to be treated is fed into a tipper, the movement of which actuates the ratchet wheel and lifts the piston a short distance, thus exposing a layer of the powder above the top of the cylinder. The tipper pivot has an arm reaching to the top of the powder cylinder and carrying a skimmer which sweeps the exposed layer of powder into a shoot leading to the mixing vessel, where it meets the liquid discharged from the tipper.—J. H. J.

*Addition of predetermined quantities of substances to a uniform or variable flow of liquid; Process of and apparatus for*—[Water softening.] B. C. Hinman, London, and E. W. Robey, South Woodford, Essex. Eng. Pat. 4435, Feb. 20, 1914.

A FIXED proportion of the main flow of water is led to a proportioning box where it flows over a horizontal weir. A fixed proportion of the flow over the weir is led to a float tank, the float in which actuates a drum regulating the proportions

of the flow over the weir taken into the chemical tank and into the main flow. In the chemical tank the reagents required for the treatment of a definite volume of the water are kept in suspension and mixed with the incoming water by agitators driven by a water wheel actuated by the main flow. The water leaving the chemical tank carries its proportional amount of reagents and passes into the main flow, which is then passed into sedimenting and filtering tanks. The amount of water entering the float tank is fixed as desired, and may be 1/500 to 1/5000 of the total volume. By calibrating the float tank, the level of the water will be an index of the volume treated.—J. H. J.

*Filtration [of water] under pressure; Apparatus for* — J. H. Missong. Ger. Pat. 280,087, Aug. 20, 1913. Addition to Ger. Pat. 260,096.

THE water may be forced through a filter on its way to the high-level reservoir mentioned in the chief patent (this J., 1913, 708). The filters may be in the form of open chambers provided with barometric fall tubes; the water from the first filter flows through the fall tube into a reservoir, which may also serve as a settling tank, and is then pumped up into the next filter.—A. S.

*Lime, or like, mixing machines [used in sewage purification].* J. B. Broadhead and D. Barker, Brighouse, Yorks. Eng. Pat. 5081, Feb. 27, 1914.

THE lime is fed to the interior of the mixing pan by means of a shoot extending through one side of the pan. A pump delivers the desired amount of water to the milk of lime flowing from the mixer, and the mixture passes into a channel extending across the sewage conduit. This channel has a sloping bottom with V-shaped slots at intervals along the bottom of the deeper side, through which the milk of lime falls into the sewage. The mixing pan is provided with a bottom outlet pipe for discharging any undissolved solids into the sewage conduit when necessary. This pipe is closed at its interior end by a valve worked by a spindle and hand wheel from above, and furnished with radial lugs with knife edges for cutting into any deposit when the valve is raised.—J. H. J.

*Plant pests; Production of mixtures for destroying* — A. Lang. Ger. Pat. 279,563, Feb. 13, 1914. Addition to Ger. Pat. 265,656 (this J., 1913, 1169; see also Eng. Pat. 20,395 of 1913; this J., 1914, 663).

A METALLOID such as carbon is intimately mixed with an equivalent quantity of sulphur and with a mixture of a metal powder and a sulphur- or oxygen-carrier, capable of developing an exothermic reaction without access of air; the mass is moulded and when required for use is ignited, whereupon the sulphur compound of the metalloid is formed.—A. S.

*Apparatus for clarifying liquids containing finely divided matter in suspension.* Eng. Pat. 7179. See I.

## XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS.

*Cinchonine; The hydrogenation of* — M. Freund and J. A. W. Bredenbergh. Chem. Ges. zu Frankfurt, Nov. 24, 1914. Chem.-Zeit., 1915, 39, 109.

ON electrolytic reduction with lead cathodes prepared by Tafel's method (see this J., 1900, 909; 1901, 48), cinchonine combines with 2 mols. of hydrogen, with loss of water, yielding two bases, one of which, dihydrodesoxycinchonine,  $C_{19}H_{24}N_2$ ,

is crystalline, m. pt.  $135^{\circ}$ — $136^{\circ}$  C.; it contains an imino group and is formed by the conversion of the  $CH(OH)$  group of cinchonine into  $CH_2$ , while two atoms of hydrogen enter the pyridine ring. It yields desoxycinchonine on treatment with iodine and is further hydrogenated in the pyridine ring by sodium and amyl alcohol, giving the tetrahydro-compound. When shaken with palladium in hydrogen it also takes up two atoms of hydrogen, the vinyl group of the side chain being converted into an ethyl group. This last product, dihydrodesoxycinchonine, can be obtained also from cinchonine by electrolytic reduction. Dihydrodesoxycinchonine, on reduction with sodium and amyl alcohol, and tetrahydrodesoxycinchonine, on reduction with hydrogen and palladium, both give the same product, which may be termed either tetrahydrodesoxycinchonine or hexahydrodesoxycinchonine.—J. F. B.

*Strychnine; Substances which mask the colour reactions of* — E. Mameli. Boll. Chim. Farm., May—Sept., 1914. J. Pharm. Chim., 1915, 11, 125—126.

THE usual scheme for the isolation of the alkaloids does not separate them from a number of common medicaments or their decomposition products such as phenacetin, *p*-phenetidine, *p*-aminophenol, phenocoll, guaiacol, heroin, sulphophenoxides, glycerol, etc., and many of these substances prevent or otherwise mask the alkaloidal colour reactions. In the case of strychnine, both the sulphuric acid and bichromate, and the sulphovanadic acid reactions are vitiated by the presence of the above substances, and the precipitation reactions with ferrocyanide and picric acid, when not actually prevented, may be rendered extremely uncertain in the presence of these and other substances owing to the precipitates which they may themselves produce. The only method of avoiding these undesirable results is to obtain the alkaloid in a sufficient state of purity by the judicious employment of suitable solvents.—G. F. M.

*Aconitine; Oxidation of* — G. Barger and E. Field. Chem. Soc. Trans., 1915, 107, 231—233.

WHEN aconitine is oxidised in acetone solution with potassium permanganate in presence of glacial acetic acid, 90% of the theoretical yield of oxonitin is obtained. Five grms. of aconitine is dissolved in 250 c.c. of acetone and 11 grms. of finely powdered potassium permanganate and 12.5 c.c. of glacial acetic acid are added in the course of five to seven days, the separated oxonitin and manganese dioxide being then filtered off and suspended in water, and the manganese dioxide removed by sulphur dioxide. Oxonitin crystallises best from boiling glacial acetic acid after addition of acetone, forming stout prisms, m. pt.  $276^{\circ}$ — $277^{\circ}$  C. When heated with hydriodic acid and phosphorus, it is converted into a substance, crystallising from alcohol in prisms, m. pt.  $121^{\circ}$ — $122^{\circ}$  C., b. pt. about  $200^{\circ}$  C. at 15 mm. The mean results of a number of analyses of recrystallised oxonitin gave C, 60.51, H, 6.66,  $CH_3O$ , 18.5%. (See also this J., 1912, 1145, 1199).—T. C.

*Pavine; Constitution of* — Constitution of the reduction products of papaverine. F. L. Pyman. Chem. Soc. Trans., 1915, 107, 176—187.

PAVINE (dihydropapaverine) on methylation yields N-methylpavine, the methoxyhydroxide of which is converted by boiling concentrated, aqueous potassium hydroxide into the methine,  $C_{22}H_{27}O_4N$ , which on oxidation with cold aqueous potassium permanganate gives a dicarboxylic acid,



ethyl acetate by *N*/10 hydrochloric acid at 0° C., 25° C., and 40° C., indicates that the ratio of the catalytic activities of the undissociated molecule and the hydrogen ion does not possess a considerable temperature coefficient as suggested by MacBain and Coleman (Chem. Soc. Trans., 1914, 105, 1520), but that, on the contrary, it is independent of temperature. The importance of a consideration of the activity of the undissociated molecule in calculations of reaction constants in acid catalyses is emphasized.—W. P. S.

*Crude calcium cyanamide as a raw material of the chemical industry.* Carlson. See VII.

#### PATENTS.

*Substituted ureas; Manufacture of new ——— [and their use for stabilising nitro-products].* Fabr. de Prod. Chim. Org. de Laire, Issy, France. Eng. Pat. 17,501, July 23, 1914. Under Int. Conv., July 29, 1913.

CLAIMS are made for new tetra-substituted ureas, of the type  $RR^1N.CO.NR^2R^3$ , where R and R<sup>2</sup> represent alkyl and R<sup>1</sup> and R<sup>3</sup> aryl radicles, and their use for stabilising nitro-derivatives (explosives, celluloid, etc.). The new products are viscous liquids or melt below 50° C., and are very soluble in organic solvents. Methylphenylethyl-*o*-tolylurea, ethylphenylmethyl-*o*-tolylurea, methyl-ethyl-di-*o*-tolylurea, and diethyl-di-*o*-tolylurea are claimed specially.—F. W. A.

*Hydroxyisopropyl derivatives of hydrocarbons and their derivatives; Preparation of ———.* Farbenfabr. vorm. F. Bayer und Co. Ger. Pat. 280,026, Sept. 9, 1913.

ACETONE-SODIUM, when obtained by the action of sodium amide on acetone in presence of ether at low temperatures, is a crystalline substance readily soluble in ether and petroleum spirit, and, unlike the known insoluble acetone-sodium, is very reactive. By its action on hydrocarbons or their derivatives, one or more atoms of hydrogen are replaced by the  $(CH_3)_2C(OH)$  group; the products are obtained in the form of their sodium compounds, from which the hydroxyisopropyl compounds are prepared by treatment with acids.—A. S.

*Panama bark; Process for the suppression of dust during the working up of ———.* R. Mandelbaum, Asperg, Germany. U.S. Pat. 1,128,472, Feb. 16, 1915. Date of appl., Aug. 19, 1913.

SEE Ger. Pat. 264,163 of 1912; this J., 1913, 1031.

*Medicinal preparation for human use.* H. Belart, Huddersfield. U.S. Pat. 1,129,270, Feb. 23, 1915. Date of appl., Oct. 8, 1913.

SEE Eng. Pat. 23,097 of 1912; this J., 1913, 989.

*Carbohydrate phosphoric acid esters; Manufacture of ———.* H. K. A. S. von Euler-Chelpin, Assignor to Aktiebolaget Astra, Apotekarnas Kemiska Fabriken, Stockholm. U.S. Pat. 1,129,321, Feb. 23, 1915. Date of appl., May 20, 1913.

SEE Fr. Pat. 458,096 of 1913; this J., 1913, 1031.

*2-Phenylquinoline-4-carboxylic acid; Preparation of ———.* Chem. Fabr. auf Actien, vorm. E. Schering. First Addition, dated April 27, 1914, to Fr. Pat. 445,529, June 27, 1912. Under Int. Conv., Aug. 1, 1913.

SEE Eng. Pat. 11,836 of 1914; this J., 1914, 889.

*Alcohol; Process and apparatus for the manufacture of ———.* W. K. Freeman. Fr. Pat. 471,621, Dec. 18, 1913.

SEE Eng. Pat. 23,923 of 1913; this J., 1915, 248.

*Ureas [; Substituted ———] and their application.* Fabr. de Prod. Chim. Org. de Laire. Fr. Pat. 472,211, July 29, 1913. \*

SEE Eng. Pat. 17,501 of 1914; preceding.

*Process of introducing iron into foods, drugs, and beverages. Process of forming compounds of iron and carbohydrates.* U.S. Pat. 1,129,306 and 1,129,307. See XIXA.

### XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES.

*Application of a variety of selenium particularly sensitive to light to the construction of selenium cells for photometry.* Angel. See XXIII.

#### PATENT.

*Photographic prints in natural colours from Lumière autochrome and other colour-sensitive lined plates; Process for obtaining ———.* M. F. Ungerer, Offenbach, Germany. U.S. Pat. 1,128,389, Feb. 16, 1915. Date of appl., Aug. 15, 1913.

SEE Eng. Pat. 17,979 of 1913; this J., 1914, 222.

### XXII.—EXPLOSIVES; MATCHES.

*Electrolysis of a solution of sodium hydrazide in anhydrous hydrazine.* Welsh. See VII.

#### PATENTS.

*Explosive.* F. Sparre, Assignor to E. I. du Pont de Nemours Powder Co., Wilmington, Del. U.S. Pat. 1,128,380, Feb. 16, 1915. Date of appl., Jan. 25, 1913.

THE explosive consists of an oxidisable carbon-containing material, a nitrate, and an alkaline-earth polysulphide.—T. St.

*Explosive.* F. R. and J. G. Burrows. Fr. Pat. 472,371, May 19, 1914.

A MIXTURE of 6 parts of ammonium perchlorate, 56 of potassium nitrate, 18 of aluminium (in coarse particles which will pass through a 30-mesh sieve, and produced by cooling the metal in water), 18 of *o*-trinitrotoluene, and 2 parts of pure paraffin wax.—B. N.

*Detonator-casings; Charge for ———.* L. Wöhler, Darmstadt, Germany, Assignor to E. I. du Pont de Nemours Powder Co., Wilmington, Del. U.S. Pat. 1,128,394, Feb. 16, 1915. Date of appl., May 10, 1911.

SEE Addition of June 27, 1911, to Fr. Pat. 387,640 of 1908; this J., 1912, 153.

*Explosive; Gelatin ———.* J. Maire, Argenteuil, Assignor to A. E. Vergé, Vincennes, France. U.S. Pat. 1,128,471, Feb. 16, 1915. Date of appl., July 22, 1913.

SEE Eng. Pat. 17,205 of 1913; this J., 1914, 943.

*New substituted ureas [and their use for stabilising nitro-products, e.g. nitrocellulose].* Eng. Pat. 17,501. See XX.

## XXIII.—ANALYTICAL PROCESSES.

*Base metal thermocouples; The constancy of — as related to the microstructure.* O. L. Kowalke. Trans. Amer. Electrochem. Soc., 1914, 26, 199—214.

THE couples tested (Ni-Cr and Ni-Fe-Si, Cr-Fe-Ni and Al-Ni, Fe and Al<sub>2</sub>Ni, Fe and Cu-Ni, Cr-Ni and Fe-Ni) showed departures of 20°—125° C. from their original calibrations. Examination of the microstructures of the separate wires before and after heat treatments for 2 hours at 400°, 600°, 800°, and 1000° C., showed that in those cases where there was considerable deviation from the original calibration, segregation occurred on heating, and it was concluded that, provided the thermo-electric force is satisfactory and the m. pt. high, those metals which form solid solutions with one another give the best results, and that silicon is not a desirable constituent in a nickel alloy for thermocouple material.—W. E. F. P.

*Selenium cells for photometry; Application of a variety of selenium particularly sensitive to light to the construction of —.* L. Angel. Bull. Soc. Chim., 1915, 17, 10—14.

VITREOUS selenium, melted at 220° C. and then cooled rapidly under pressure, changes into a new, very unstable, crystalline variety of greyish violet appearance which is very sensitive to light. By choosing suitable conditions of heat and pressure it is possible to obtain a kind of solid solution of this variety in vitreous selenium which is much more stable, and is suitable for the construction of photo-electric cells. Two parallel naked copper wires wound on an insulating bobbin at a distance of not more than 0.04 mm. apart form the electrodes, and the selenium is spread over to bridge the gap. The minute quantity of metallic selenide formed acts as a sensitizer, and greatly enhances the sensitiveness of the selenium. With this construction the conductivity of the selenium varies almost as rapidly as the illumination, and its inertia is practically negligible. The cells have been successfully used for the photometric study of heat radiations, X-rays, cathode rays, and the solar eclipse. —G. F. M.

*Freezing-point depression of dilute solutions; The measurement of —.* I. H. Adams. J. Amer. Chem. Soc., 1915, 37, 481—490.

THE method provides a means of measuring the freezing-point depressions of solutions of the order  $N/10$  to  $N/200$  with an accuracy sufficient to enable comparison to be made with results derived from conductivity measurements; this involves the determination of the depression to 0.0001° C. and of the equilibrium concentration with commensurate accuracy. Two similar vacuum-jacketed vessels are completely surrounded by ice in a large closed pot insulated by a layer of felt: the vessels contain pure water and the solution, respectively, and in each case stationary equilibrium with a large quantity of ice is achieved by using a small circulating pump. The depression is determined directly by means of a 50-junction copper-constantan differential thermo-element (giving 2000 microvolts per 1° C.). The E.M.F. is read to 0.1 microvolt. The concentration of the equilibrium solution is determined (to about 2 parts of solute per million of water) by means of a Zeiss interferometer. The observed and calculated freezing-point depressions for five solutions of mannitol were, respectively, 0.0075, 0.0075; 0.0157, 0.0156; 0.0260, 0.0261; 0.0525, 0.0525; 0.1162, 0.1162. Results are also quoted for aqueous solutions of potassium nitrate and potassium chloride at concentrations ranging from  $N/250$  to  $N/10$ .—J. R.

*Electrometric titrations.* H. Ziegel. Trans. Amer. Electrochem. Soc., 1914, 26, 91—97.

DETAILS are given of a device by means of which the change in potential occurring in a solution at the end-point of a titration is utilised for automatically closing the stopcock of the burette when the end-point is reached. The apparatus is similar to that of Forbes and Bartlett (J. Amer. Chem. Soc., 1913, 35, 1527), a Weston No. 30 relay replacing the ordinary galvanometer.\* A telegraph sounder with a narrowed arm, 7 in. long, is attached to each extremity of the stopcock, which is thus indirectly opened or closed by the movement of the needle of the Weston instrument. The solution is stirred rapidly by the elongated shaft of a battery motor; this shaft is heavily plated with platinum and tipped with a deeply nicked disc of platinum, the latter forming the oxygen electrode with which a calomel electrode of ordinary form is used. In the titration of a sulphuric acid solution of potassium bichromate with ferrous sulphate, the burette readings obtained automatically were concordant and in close agreement with those obtained manually by the use of a spot plate.† It is proposed to apply the apparatus to the titration of iron (as indicated) and zinc (by ferrocyanide). —W. E. F. P.

[Testing of] metropolis gas. See IIA.

*Determination of weighting of silk.* Heermann and Frederking. See VI.

*Determination of small quantities of hydrocyanic acid.* Viehovec and Johns. See VII.

*Hygroscopic and total water in plaster of Paris.* Canals. See IX.

*Determination of manganese in ferrovanadium.* Clark. See X.

*Determination of gases in smelter flues and of dust losses.* Dunn. See X.

*Analysis of tanning materials intended especially for the tanning of fishing nets.* Van Dorp. See XV.

[Determination of] degree of tannage. James. See XV.

*Determination of sucrose in frozen and thawed beets [by the double polarisation method, using acid and invertase as hydrolysts].* Saillard. See XVII.

*New method for determining the activity of diastase.* Wolff. See XVIII.

*Microscopical detection of potato starch in bread.* Schlütz and Wein. See XIXa.

*Determination of sulphur in peptone [e.g., in culture media]. Determination of sulphur in the culture medium for the detection of the bacteria producing hydrogen sulphide.* Redfield and Huckle. See XIXb.

*Substances which mask the colour reactions of strychnine.* Mameli. See XX.

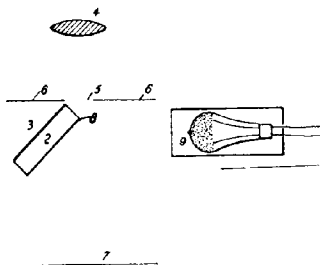
*Velocity of saponification of linalyl, terpenyl, and geranyl acetates. [Detection of terpenyl acetate in bergamot oil.]* Barillet and Berthelès. See XX.



## PATENTS.

**Photometers.** J. M. G. Trezise, Croydon. Eng. Pat. 6319, March 12, 1914.

LIGHT from a standard lamp, 9, falls on a glass slab, 2, with opal backing, 3, the reflected light from the end of the slab being viewed through the



hole, 5, in the screen, 6. Direct light from the luminous surface, 7, the brilliancy of which is to be measured, passes through the hole, 5, for comparison. The edge, 8, forms a sharp dividing line between the luminous areas to be compared, and may be magnified by the lens, 4. To compare two light sources, two slabs such as 2, but oppositely inclined, are used, the visible edges slightly overlapping.—W. F. F.

**Thermometer; Electrical resistance**——. The Cambridge Scientific Instrument Co., Ltd., and W. H. Apthorpe, Cambridge. Eng. Pat. 20,248, Sept. 25, 1914.

A DOUBLE metal wire is wound in a double helical thread, cut on the surface of a tube or rod of porcelain, steatite, glass, or the like, the surface is then coated with a suitable fusible material, and the whole is heated until the material is fused on to the surface.—B. N.

**Gaseous mixtures with known constituents; Quantitative analysis of**——. Siemens und Halske A.-G. Ger. Pat. 278,676, July 3, 1913. Addition to Ger. Pat. 275,084.

IN carrying out the process described in the chief patent (see Fr. Pat. 458,916 of 1913; this J., 1913, 1171), the gas used as a standard for comparison and the gas under examination are kept under the same conditions of temperature and pressure, and the speed of the centrifugal device is controlled by the manometer for the standard gas. In this way the indications are

rendered independent of fluctuations of temperature and pressure.—A. S.

## XXIV.—MISCELLANEOUS ABSTRACTS.

**Gases; The analysis of**——after passage of electric discharge. A. C. G. Egerton. Proc. Roy. Soc. 1915, A., 91, 180—189.

ELECTRIC discharges were passed, using three coils of different sizes with different types of interrupters, through tubes of various shapes and sizes with palladium, platinum, and aluminium electrodes, and the residual gases were analysed with the aid of phosphorus and charcoal in various ways. No production of helium or neon was observed. From theoretical considerations it is also held that, if such a production has an origin other than from atmospheric contamination, the source must be in some action on the electrodes or the glass composing the discharge tube. (See also this J., 1913, 231; 1914, 1087.)—B. N.

**Binary mixtures; Molecular structure of isotropic and anisotropic**——. [Silica-boric oxide glasses, and gold-silver and gold-copper alloys.] G. Tammann. Z. anorg. Chem., 1914, 90, 297—326.

THE paper deals with the action on a binary mixture of a solvent in which one component is soluble and the other insoluble. For isotropic mixtures, in which there is no regular arrangement of the molecules of the components, the probability of a molecule of the soluble component being protected against the action of the solvent by a definite number of molecules of the second component may be calculated with the aid of the laws of chance. In the case of glasses composed of fused mixtures of silica and boric oxide, submitted to the action of water and of a solution of hydrochloric acid in methyl alcohol (cf. this J., 1896, 220) respectively, the proportion of boric oxide left undissolved in the glasses containing 1 mol. B<sub>2</sub>O<sub>3</sub> to 1 mol. SiO<sub>2</sub> or 1 mol. B<sub>2</sub>O<sub>3</sub> to 2 mols. SiO<sub>2</sub> agreed fairly well with the values calculated on the assumption that 1 mol. B<sub>2</sub>O<sub>3</sub> is protected by 5 mols. SiO<sub>2</sub>; in the glasses richer in boric oxide the proportion of the latter left undissolved was considerably greater than the calculated values, a result attributed to adsorption by the insoluble residue.

In the case of binary mixed crystals, the molecules of the components may be distributed without any regular arrangement in the space-lattice forming the framework of the crystal structure, or they may be distributed symmetrically. With the first arrangement the composition of the residue left undissolved by a selective solvent should agree with

% Ag in alloy.	Time of extraction, hours.	Percentage loss of weight of gold-silver alloys.			% Cu in alloy.	Percentage loss of weight of gold-copper alloys.	
		“Hard,” after rolling.	Annealed at 820° C. for:			“Hard,” after rolling, 10 hours' extraction.	Annealed for 49 hours at 700° C. 13 hours' extraction.
			41 hours.	111 hours.			
50-00	9-5	49-01	49-43	49-70*	60-12	60-01	60-23
44-92	9-5	9-80	3-39	—	55-04	54-82	55-33
44-92	15-5	34-37	22-55	44-17*	50-12	49-85	49-05
39-88	9-5	1-63	0-58	—	45-14	44-85	44-89
39-88	15-5	9-71	1-86	—	39-96	39-67	35-11
39-88	27-5	15-89	6-57	17-67*	35-24	33-15	22-58
39-88	40-5	23-84	12-40	—	30-00	13-46	1-65
34-94	27-5	1-43	0-32	0-24*	21-00	0-45	0-27
34-94	40-5	2-13	1-04	—	10-14	0-15	0-27

\* Time of extraction, 28 hours.

that calculated from the laws of probability. It is shown that with the second arrangement in the case of crystals having a cubical space-lattice, the whole of the soluble component should be removed by a selective solvent from mixtures containing more than 62.5 mols. % of the soluble component and practically none from mixtures containing less than 50 mols. %; also that a certain proportion of the soluble component should be dissolved much more rapidly than subsequent portions. Experiments with gold-silver and gold-copper alloys were in good agreement with the view that the molecules of the components are arranged symmetrically in the space-lattice. Small plates of the alloys ( $2 \times 4 \times 0.01$  cm.) were heated with nitric acid of sp. gr. 1.3 under a reflux condenser and the loss of weight determined. Some of the results are collected in the preceding table. A. S.

## Trade Report.

### *Prohibited exports. Additions to List.*

A ROYAL Proclamation, dated March 18th, amends and adds to the Proclamation of Feb. 3rd, 1915 (see this J., 1915, 154) as follows:—

The heading "Thorium nitrate" in the list of goods the exportation of which is prohibited to all destinations is deleted, and there is substituted the heading "Thorium oxide, thorium nitrate, and other salts of thorium."

The heading "Salicylic acid and salicylate of soda" in the list of goods the exportation of which is prohibited to all destinations is deleted, and there is substituted the heading "Salicylic acid, salicylate of soda and methyl salicylate."

The heading "All vegetable oils (other than linseed oil, boiled and unboiled, unmixed with other oil, and not including essential oils)" in the list of goods the exportation of which is prohibited to all destinations abroad other than British Possessions and Protectorates is deleted, and there is substituted the heading "Oils, all vegetable, and fats (other than linseed oil, boiled and unboiled, unmixed with other oil and not including essential oils)."

The heading "Oleo oil, Premier jus, and animal tallow" in the list of goods the exportation of which is prohibited to all destinations abroad other than British Possessions and Protectorates is deleted, and replaced by the heading "All animal oils and fats."

The heading "Rubber (including raw, waste and reclaimed rubber) and goods made wholly of rubber, including tyres for motor vehicles and for cycles, together with articles or materials especially adapted for use in the manufacture or repair of tyres" in the list of goods the exportation of which is prohibited to all destinations abroad other than British Possessions and Protectorates is deleted, and there is substituted therefor the heading "Rubber (including raw, waste and reclaimed rubber, solutions containing rubber, jellies containing rubber, or any other preparations containing rubber) and goods made wholly of rubber; including tyres for motor vehicles and for cycles, together with articles or materials especially adapted for use in the manufacture or repair of tyres."

The following articles are added to the list of goods the exportation of which is prohibited to all destinations abroad other than British Possessions and Protectorates:—Ammonia and its salts,

whether simple or compound, other than ammonium nitrate, perchlorate and sulphocyanide (the exportation of which is already prohibited to all destinations). Ammonia liquor. The compounds of aniline, except aniline salt (the exportation of which is already prohibited to all destinations). Chloride of tin. Copper iodide. Tanning substances of all kinds (including extracts for use in tanning) except chestnut extract, oak-wood extract, and valonia (the exportation of which is already prohibited to all destinations). Urea and its compounds. Tin and tin ore. Neat's foot oil.

### *Contraband of War.*

A ROYAL Proclamation, dated March 11th, declares the following articles to be "absolute contraband": Tin, tin ore, tin chloride; castor oil; paraffin wax; copper iodide; lubricants; ammonia and its salts; ammonia liquor; urea, aniline, and their compounds. It is further declared that tanning substances of all kinds (including extracts for use in tanning) will be treated as "conditional contraband," and that the terms "foodstuffs" and "feeding stuffs for animals" in the earlier Proclamations shall include oleaginous seeds, nuts, and kernels; animal and vegetable oils and fats (other than linseed oil) suitable for use in the manufacture of margarine; and cakes and meals made from oleaginous seeds, nuts, and kernels.

These items are in addition to those enumerated in the Royal Proclamation of Dec. 23rd last (see this Journal, 1914, 1230).

### *Russian Customs Tariff; Proposed revision of the —. Board of Trade, Commercial Dept., March, 1915.*

THE Board of Trade have received, through the Foreign Office, a translation of an article, giving particulars of certain projected modifications of the Russian Customs Tariff, which, it is understood, have been under the consideration of the Russian Government. The proposals for tariff modification are, in their latest and revised form, as follows:—

(1) The "conventional" rates of duty resulting from the Russian Commercial Treaties with Germany and Austria-Hungary are to be abrogated, and the goods covered by those rates are to be cleared at the "General" tariff rates of duty, increased by 10% (except as regards certain goods mentioned under (3) below, in respect of which specially increased rates are to be imposed).

(2) No change is to be made as regards goods the duties on which are fixed by the Russian Commercial Treaties with France, Italy, and Portugal.

(3) Certain goods, including spirits and beer, certain glass wares, rubber (crude), certain colours, cotton, jute, wool, cotton yarns, and certain cotton tissues, are to be subject to special augmented rates of duty.

(4) The existing rates on a small number of articles are to be maintained in force. These articles include: cocoa in the bean and cocoa husks; cooking salt of all kinds; manures; bones, prepared or not; sulphate of ammonia; cast iron in pigs, scrap, and shavings, except manganese (ferro-manganese), ferro-silicon, and ferro-chrome; paper pulp (mechanical)—wood pulp; paper clippings and waste; paper pulp (chemical)—cellulose pulp made from rags.

(5) All other goods are to pay the existing "General" Tariff rates of duty, increased by 10%.

A comparative statement showing the present and proposed rates in detail, has been prepared. No information is at present available as to the date from which the temporary tariff is to come into operation.

*Chemical industry [in the United States]: The war and the —.* W. H. Nichols. Amer. Assoc. for the Advancement of Science, Dec. 30, 1914. J. Ind. Eng. Chem., 1915, 7, 131—136.

THE effect of the war upon the chemical industry in the United States has been mainly indirect, certain industries directly affected having reduced their consumption of chemicals. In the case of certain heavy chemicals for which the supply of raw materials has been curtailed or entirely cut off, there has been a sharp advance in prices, but there has been no general rise in prices as a result of the war. The United States imports a considerable proportion of its sulphur in the form of pyrites, nearly all of its potash, and all of its nickel, tin, and sodium nitrate, but in consequence of the command of the sea by the Allies only the importation of potash has been greatly affected by the war. It is suggested that less potash could be used on the soil than hitherto without any great disadvantage. The coal tar colour industry is dealt with at some length, and it is noted, incidentally, in regard to fuming sulphuric acid which is largely used in this industry, that the United States produces more sulphuric acid by the contact process than any other country in the world, and possibly more than all other countries combined. An attempt to manufacture aniline oil in the United States some years ago failed owing to the foreign product being offered at less than cost price; and it is stated that at the present time, when there is no longer any prospect of procuring additional protection of new industries through the tariff, it will be rash to hope that American capital and enterprise should further embark in any of those industries firmly entrenched abroad, and where, as soon as the war is over, foreigners can attack or destroy the local industry by dumping their products at unfairly low prices. It is urged that the anti-trust sections of the Wilson Tariff Act should be amended so as to include therein the prohibition against monopolising of the Sherman Act, even when practised by one person alone, and that the restraint of trade by dumping of goods at unfairly low prices be expressly defined as an act of monopolising.—A. S.

### Book Received.

BULLETIN OF THE IMPERIAL INSTITUTE. Vol. XII. No. 4. Oct.-Dec., 1914. Price 2s. 6d.

THIS issue contains the results of investigations in connection with soils from the East Africa Protectorate, tea from new sources, nuts of *Canarium* species, beans from British West Africa, and barley from Cyprus; also special articles on the new developments in the work of the Imperial Institute, the industrial position of copra, coconut oil, and coconut cake, and an article on the economic resources of German East Africa.

### \* New Books.

[The Roman numerals in thick type refer to the similar classification of abstracts under "Journal and Patent Literature" and in the "List of Patent Applications."]

**I. Haase, F. H.:** Feuerung u. Feuerungsanlagen. (VI, VII, 225 S. m. 121 Fig. im Text u. auf 1 Taf.) gr. 8°. Berlin. Geschäftsstelle der Zeits. Luftg. u. Heizg. 1915. M. 4.50.

**Winkelmann, H.:** Fabrik-Neuanlagen u. Erweiterungen. (28 S.) gr. 8°. Kattowitz. Gebr. Böhm. 1915. M. 1.20.

**IIA. Beckmann, E.:** Verfahren zur Prüfung der Luft auf Gehalt an brennbaren Stoffen. Nach gemeinsamen Versuchen m. K. Steglich. (S. 924—936 m. 2 Fig.) Lex 8°. Berlin. G. Reimer. 1914. 50 Pf.

**Donath, Prof.:** Oberflächenverbrennung u. "flammenlose" Feuerungen. (V. 84 S. m. 40 Abbildgn.) gr. 8°. Halle. W. Knapp. 1914. M. 4.20.

**Keppeler, G.:** Die Aufgaben der technischen Moorverwertung; **Birk, C.:** Das Tote Moor am Steinhuder Meer. Eine moorkundl. Studie. Mit 5 Skizzen, 8 Bildern u. 5 Taf. (XVI, 102 S.) Lex 8°. Braunschweig. F. Vieweg & Sohn. 1914. M. 8.

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**Schmitz, Dr. P. M. E.:** Eine neue Oelprobiermaschine zur Prüfung der Schmieröle bei jeder Temperatur, unter Anwendung verschiedener Metalle als Gleitfläche. (4 S. m. 4 Fig.) Lex 8°. Berlin. Verlag f. Fachliteratur. 1914. M. 1.

**IIB. Gaster, L. and Dow, J. S.:** Modern illuminants and illuminating engineering. Illustrated. 8vo. pp. 476. Whittaker. 1915. Net 12s. 6d.

**Schwartz:** Entwicklung u. gegenwärtiger Stand der Grubenbeleuchtung beim Steinkohlen-Bergbau. (193 S. m. Fig.) gr. 8°. Gelsenkirchen. C. Bertenburg. 1914. Cloth, M. 6.

**III. Schoeller, Dr. A.:** Ueber Seleno-Naphten-Chinon. (III, 45 S. m. 1 Taf.) gr. 8°. Oldenburg. G. Stalling's Verl. 1914. M. 4.50.

**Trutwin, Dr. H.:** Ueber Umlagerungs-Reaktionen bei Arylamiden der m-Nitrobenzolsulfonsäure. (IV, 38 S.) gr. 8°. Oldenburg. G. Stalling's Verl. 1914. M. 3.

**IV. Dyestuffs and coal-tar products:** their chemistry, manufacture and application. By various authors. Reprinted, with additions, from "Industrial manufacturing chemistry." Royal 8vo. pp. 164. Crosby Lockwood. London. 1915. Net 7s. 6d.

**Willstätter, R. u. H. Mallison:** Ueber die Verwandtschaft der Anthocyane u. Flavone. (S. 769—777.) Lex 8°. Berlin. G. Reimer. 1914. 50 Pf.

**VII. Baerwind, Dr. E.:** Ueber die thermoelektrischen Eigenschaften des Siliciums. (III, 44 S. m. 6 Abbildgn.) gr. 8°. Oldenburg. G. Stalling's Verl. 1914. M. 2.50.

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